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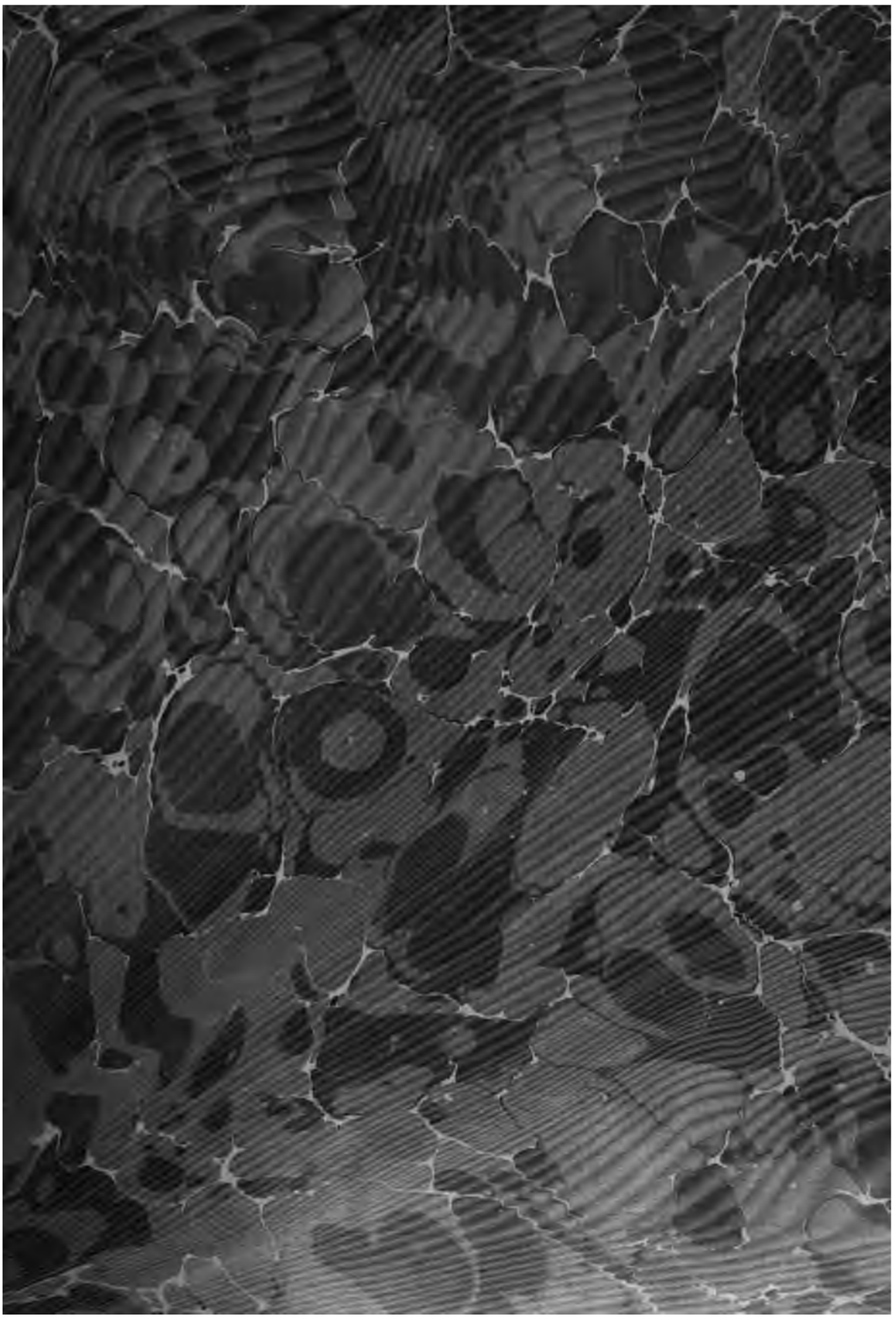

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SURGICAL ANATOMY

DEAVER

GENERAL ARRANGEMENT OF CONTENTS

VOLUME I. — Upper Extremity — Back of Neck — Shoulder — Trunk — Cranium — Scalp — Face.

VOLUME II. — Neck — Mouth — Pharynx — Larynx — Nose — Orbit — Eyeball — Organ of Hearing — Brain — Male Perineum — Female Perineum.

VOLUME III. — Abdominal Wall — Abdominal Cavity — Pelvic Cavity — Chest — Lower Extremity.

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SURGICAL ANATOMY

A TREATISE ON HUMAN ANATOMY IN ITS APPLICATION TO THE PRACTICE OF MEDICINE AND SURGERY

BY

JOHN B. DEAVER, M. D.

SURGEON-IN-CHIEF TO THE GERMAN HOSPITAL, PHILADELPHIA

IN THREE VOLUMES

ILLUSTRATED BY 499 PLATES NEARLY ALL DRAWN FOR THIS WORK FROM ORIGINAL DISSECTIONS

VOL. I.

UPPER EXTREMITY; BACK OF NECK; SHOULDER; TRUNK; CRANIUM; SCALP; FACE

PHILADELPHIA
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Surgeons and to Students of Surgery and Anatomy,

WHOSE LABORS IT IS INTENDED TO LIGHTEN IN A FIELD WHERE
LABOR ALONE IS THE PRICE OF ATTAINMENT,

THIS WORK

IS RESPECTFULLY DEDICATED
BY THEIR FRIEND AND FELLOW-STUDENT

THE AUTHOR.

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experience, and arranging the whole as systematically as possible, to make for the student and practical doctor a work of reference which is, comparatively speaking, complete.

The illustrations have been for the most part made from dissections, and are, therefore, original and accurate. Too much praise can not be given the artists and engravers who have expended in their production infinite care and an interest which has been most conscientious. I believe that use will lead to appreciation of the great value of their labors.

I take this opportunity to thank, and acknowledge the services of, Dr. Carl Hamann, my old student and house surgeon, now Professor of Anatomy in the Western Reserve University, Cleveland, Ohio, for reading the manuscript; Dr. J. Rex Hobensack, formerly my prosector in the University of Pennsylvania, for the excellent dissections from which the illustrations were made and for other valuable services in the preparation of this book, and Dr. A. D. Whiting, for making the index.

1634 WALNUT STREET,
PHILADELPHIA.

SURGICAL ANATOMY.

UPPER EXTREMITY.

SURFACE ANATOMY OF THE UPPER EXTREMITY.

Divisions.—The upper extremity is divisible into the shoulder, the arm, the forearm, the wrist, and the hand.

The **Articulations** to be studied are the *shoulder*; the *elbow*; the *superior* and *inferior radio-ulnar*; the *radio-carpal*, or *wrist*; the *carpo-metacarpal*; the *metacarpo-phalangeal*, of which there are five; and the *phalangeal*, of which there are nine.

The various **Movements** should be borne in mind. The upper extremity, as a whole, can be rotated on its axis at the shoulder-joint, so great freedom being provided that any part of the body can be touched by one or the other hand. At the elbow the movements are flexion and extension: the former is limited by the contact of the forearm with the arm, and the latter by the contact of the olecranon process of the ulna with the humerus. Through the radio-ulnar articulations the forearm is supinated and pronated, and extreme pronation and supination are permitted by rotation of the humerus. Through the radio-carpal, or wrist, articulation the hand is flexed and extended on the forearm. The metacarpo-phalangeal and inter-phalangeal articulations provide for the opening and closing of the fist and the spreading of the fingers.

If the forearm be supinated and in the extended position, it will be noticed that a line drawn in the long axis of the arm will form at the elbow an obtuse angle, with a line drawn in the long axis of the forearm. The opening of the angle is directed outward. (Plate II.) This difference in direction is known as the *ulnar deflection*, and should be carefully noted, as it is of importance in the treatment of fractures at or near the elbow-joint. The strength of the arm and its adaptability to various functions depend to some extent upon the maintenance of this angle. With the forearm extended and midway between pronation and

supination, the lines are practically parallel; while in extreme pronation, the lines form an obtuse angle, the opening of which is directed inward instead of outward.

Surface Markings.—Before commencing the dissection of the upper extremity the surface markings should be studied. The **clavicle** is readily felt, even in the stoutest persons. It is convex forward at its inner two-thirds, and concave forward at its outer one-third. The clavicle has a slightly downward slope when the body is in the upright position and with the arm at the side; but it is a little raised when the body is in the supine position. Advantage is taken of these facts in the reduction and treatment of fractures and dislocations of the clavicle. Its articulation with the sternum is easily felt, while that with the acromion process of the scapula, forming the bony arch of the shoulder, is not so easily distinguished. This prominence, formed by the bony arch of the shoulder, must not be confounded with the roundness of the shoulder, which is occasioned by the greater tuberosity and head of the humerus and the superimposed deltoid muscle. After amputation at the shoulder-joint the prominence of the shoulder remains, but the roundness is lost, owing to the removal of the upper end of the humerus. The relation of these bony points is important in the diagnosis of dislocations of the head of the humerus. A "deltoid tubercle" is sometimes present at the outer one-third of the clavicle, and must not be mistaken for an exostosis.

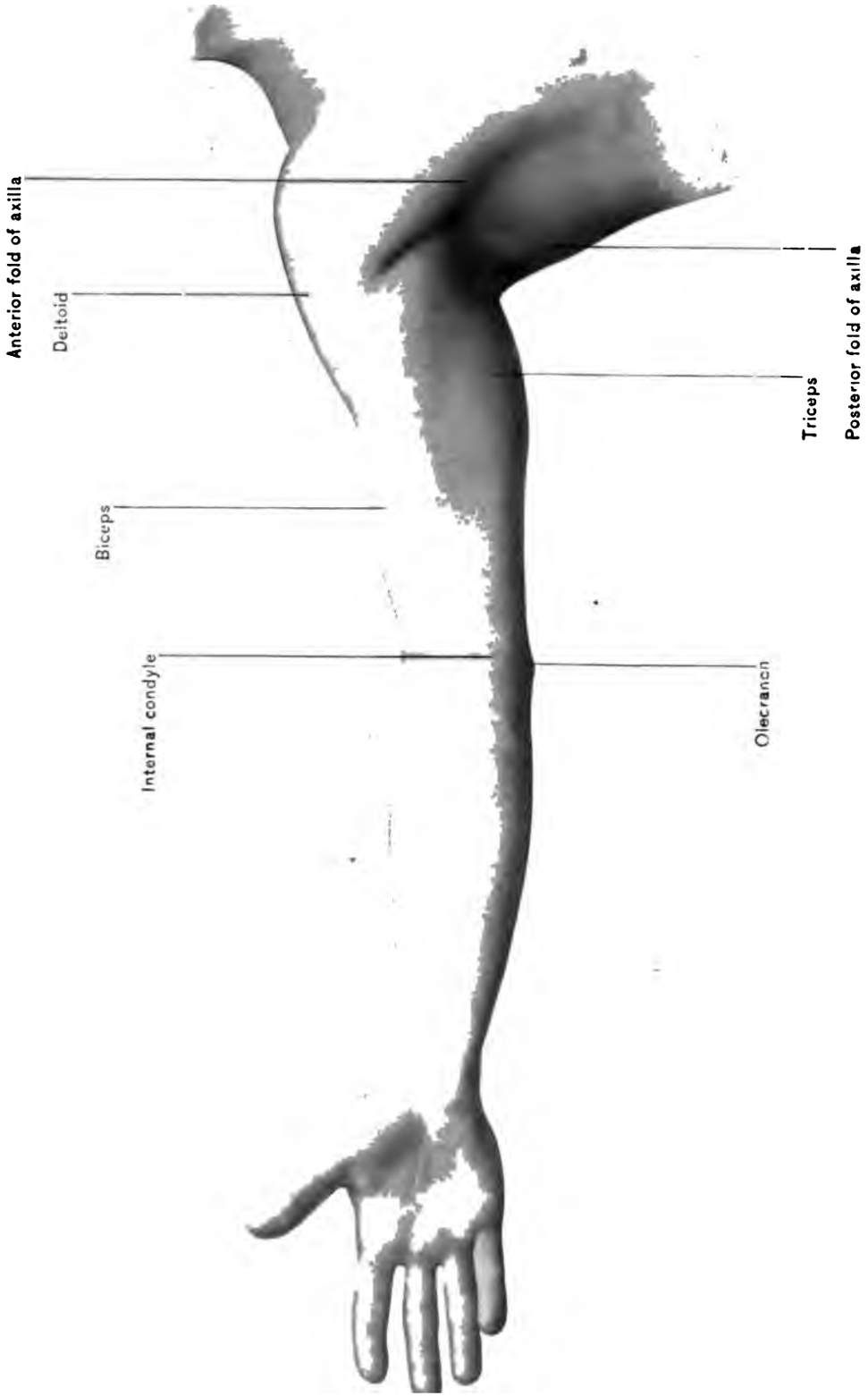
The **infra-clavicular fossa.**—This is a depression seen immediately below the middle of the clavicle, and corresponds to the interval between the origins of the pectoralis major and deltoid muscles. It is less evident in muscular persons than in those not so well developed.

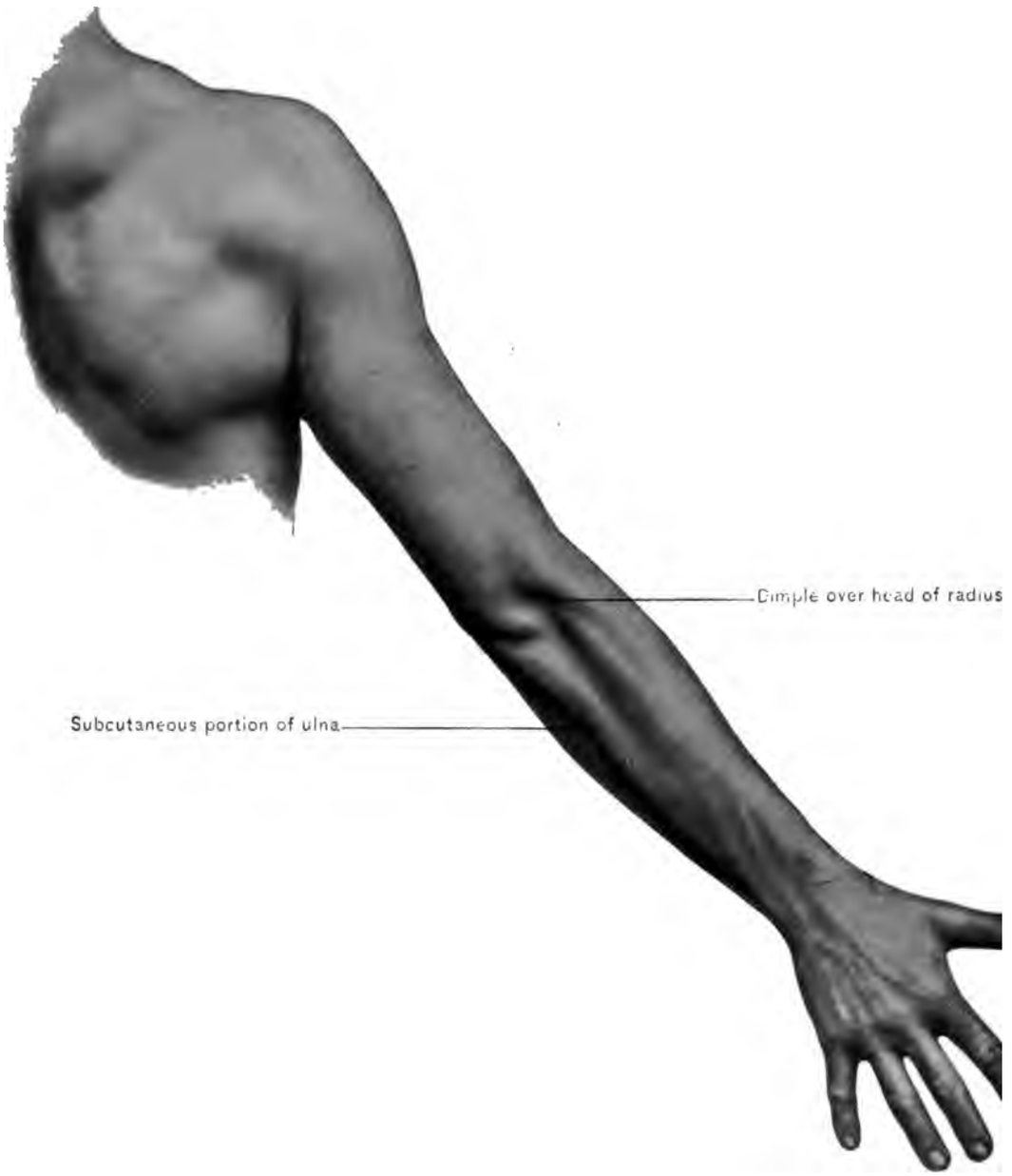
The **coracoid process** does not give rise to any visible external eminence, except in very thin persons, but can be palpated by introducing the finger into the infra-clavicular fossa and displacing the anterior border of the deltoid upward and outward.

The **acromion process** and the spine of the scapula are subcutaneous and very prominent. The acromion may consist of one or two separate pieces which have failed to co-ossify with the spine of the scapula; so that there may be one or two epiphyses, which, if incompletely united with the rest of the bone, might be mistaken for fragments of a fractured acromion. The epiphyses, if present, will be found on both sides, while it would be rare to find a fracture on more than one side. The angle formed by the acromion process and the spine of the scapula is readily made out, and affords a convenient point from which to measure in comparing the lengths of the arms. In taking these measurements, the lower points selected are the external condyle of the humerus and the tip of the styloid process of the radius. The two arms should, it is needless to mention, be placed in the

PLATE I.

PLATE III.


Anterior fold of axilla
Deltoid
Biceps
Internal condyle
Posterior fold of axilla
Triceps
Olecranon


Dimple over head of radius
Subcutaneous portion of ulna

The **biceps muscle** stands out as a well-rounded prominence on the anterior surface of the arm. It is limited on each side by a more or less well-marked groove. The internal groove contains the principal vessels and nerves of the arm; the outer, the cephalic vein.

The **deltoid muscle** can be easily recognized covering the greater tuberosity of the humerus. Paralysis and subsequent atrophy of this muscle will cause part of the roundness of the shoulder to disappear. Through this muscle the greater tuberosity of the humerus can be distinctly felt. The prominence immediately below the acromion, and felt most plainly if the arm be rotated on its long axis, is the greater tuberosity. To the inner side of and a little below the greater, the lesser tuberosity can be felt. By making pressure in a vertical line between these two prominences, the arm being rotated outward and hanging at the side, the bicipital groove, which accommodates the long tendon of the biceps, can be felt. In dislocation of this tendon—which, however, is quite rare—the groove becomes much more perceptible to the sense of touch.

The **head of the humerus** is most readily felt by inserting the fingers into the axilla. In subglenoid dislocation of the head it will be felt in the axilla as a very prominent mass.

The **coraco-acromial ligament** is distinctly felt under the anterior fibers of the deltoid. The midpoint of this ligament corresponds to the site of the bicipital groove and the long tendon of the biceps.

The **course of the axillary artery,** with the arm at a right angle to the body, is indicated by a line extending from a point slightly to the inner side of the middle of the clavicle to the middle of the bend of the elbow.

The **axilla.**—The lower margin of the anterior wall of the axilla (the lower border of the pectoralis major) follows the fifth rib. Normally, the **glands** of the axilla are not palpable. The skin of the floor of the axilla is covered by an elongated patch of hair. In the skin and superficial fascia of the floor of the axilla are modified sebaceous and sweat glands. These, especially the sebaceous glands, not infrequently become infected, when, if not treated antiseptically, they may infect the glands of the axilla. These glands are occasionally the site of primary malignant disease. An abscess of the axilla should be opened midway between the anterior and posterior walls, the incision being carried from the arm toward the chest to avoid injuring the large vessels which course along the outer wall.

The **course of the vessels and nerves** of the arm, as in other parts of the body, is along protected routes. They pass from the axilla along the inner side of the arm, thence in front of the elbow, and between the muscles of the upper forearm. In the lower third of the forearm they lie near the surface, between the flexor tendons. Upon the digits they lie on the sides, where they are more pro-

tected. The veins, injury of which is less dangerous than that of either the arteries or the nerves, are more superficial.

The **deep and the superficial veins** communicate freely at the joints, thus insuring a free and uninterrupted return circulation during strong and continuous muscular contraction. They have a larger total capacity than the arteries, and this alone is ample reason for the slower flow of the venous current. They contain numerous valves, which are necessary on account of the deficient contractile power of the veins. The blood in them can not recede, because of the closing of the valves, which hold it in lock until extraneous muscular contraction or cardiac and vasomotor vis a tergo push the contained blood forward; or until a change of position favors the descent of the blood by gravity. The promptness with which the veins are emptied by gravity is quickly and easily demonstrated by the simple experiment of holding one hand over the head while the other hangs loosely at the side. If, after remaining in this position for about one-half of a minute, the hands are brought together in front, the previously uplifted one will appear bloodless while the other will show well-filled vessels.

The **course of the brachial artery,** with the arm at a right angle to the body, corresponds to a line extending from a little to the inner side of the middle of the clavicle to the middle of the bend of the elbow. The artery is overlapped by the inner edge of the biceps muscle. It is readily reached in any part of its course, and is easily compressed at its middle, where it lies upon the insertion of the coraco-brachialis, opposite the insertion of the deltoid.

The **dimple behind the elbow,** so much admired in a well-rounded forearm, and so evident in children, who are generally well supplied with fat, is the depression below the outer humeral condyle. It indicates the position of the head of the radius, which can be felt rotating when the arm is alternately pronated and supinated. In thin persons, and on the back of the forearm while in extreme pronation, the bicipital tuberosity of the radius can be felt below the head of the radius.

The **supra-condyloid process** is a hook-shaped spicule of bone which occasionally projects from above the inner condyle of the humerus. It often gives origin to a third head of the pronator radii teres muscle, which covers the brachial artery. This process must not be mistaken for an exostosis; it is the rudiment of a process of bone which forms the supra-condyloid foramen in some of the mammalia. In these animals the foramen transmits the brachial artery and the median nerve.

Bursæ are present over the olecranon, the back of the upper end of the ulna,

olecranon process of the ulna. In their normal condition, with the forearm fully extended, the tip of the olecranon and the two condyles lie in the same transverse line. If the forearm be flexed, the olecranon process will lie below a line drawn from one condyle to the other. The vertical limits of the elbow-joint are indicated above by an intercondyloid line; below, by the lowest part of the head of the radius.

Extreme elbow flexion arrests the flow of blood in the brachial artery below this joint.

THE FOREARM AND WRIST.

The **ulna** is subcutaneous along its posterior border throughout its entire length when the forearm is supinated, but in pronation the muscles of the back of the forearm overlap the ulna and obscure it. Irregularities of the posterior border of the shaft are, therefore, very readily detected during supination.

The **radius** is so enveloped by muscle in its upper half that, with the exception of its head, it is beyond reach; but in its lower part it is quite accessible, being even subcutaneous at its lower end. The lower end of the radius extends further downward and forward than does that of the ulna.

The **course of the radial artery** corresponds to a line extending from the middle of the bend of the elbow to the inner side of the base of the styloid process of the radius. The artery is overlapped in its upper *one-half* by the supinator longus muscle. To reach it at this part of its course it is therefore necessary to displace the inner edge of this muscle outward.

The **ulnar artery** takes a curved course, which may be represented by two lines: The line for the upper one-third of the artery is drawn from a point one-half of an inch below the middle of the bend of the elbow to the inner border of the forearm at the junction of its upper with its middle one-third; the line for the lower two-thirds of the artery is drawn from midway between the internal condyle and the middle of the bend of the elbow to the radial side of the pisiform bone. In consequence of the superficial location of the arteries of the upper limb, and their occasional anomalous course, their exact position should be ascertained by digital palpation before the skin is incised.

Study of the front of the carpus reveals the following points: The tubercle of the scaphoid, below the styloid process of the radius and to the inner side of the thumb extensors; the trapezium, a little below the tubercle of the scaphoid; the pisiform bone, just below the ulna on the palmar surface, at the base of the hypothenar eminence; the cuneiform bone, upon the inner side of the pisiform; several transverse furrows in front of the wrist, the lowest of which marks the upper edge of the anterior annular ligament and the line of the intercarpal joint; the

tendons, when the wrist is flexed; the pulsation of the radial artery where it lies on the outer side of the flexor tendons (between the tendons of the supinator longus and flexor carpi radialis); the tendon of the flexor carpi ulnaris, which overlaps the ulnar artery, thus masking its pulsation. The level of the radio-carpal, or wrist, joint corresponds to the interval between the styloid process of the radius and the tubercle of the scaphoid. Incisions into the front of the wrist for the evacuation of pus should be made upon the ulnar side of the flexor carpi radialis tendon, and rather close to it, so as to avoid the radial artery, externally, and the median nerve, internally, which lies a little to the ulnar side of this tendon. Too deep an incision may enter the flexor sheath or great carpal bursa.

The **pulse.**—The pulsation of the radial artery in front of the lower end of the radius, upon the radial side of the flexor carpi radialis tendon, is commonly known as the "pulse." Sometimes the superficialis volæ arises high up and descends with the radial, thus giving the impression of a double pulse (pulsus duplex). At other times the radial artery turns backward over the radius higher up than usual, and then the pulse is not found in its normal position.

"The anatomic snuff-box" is a designation given by the French to the space upon the radial side of the back of the wrist between the first and second thumb extensors. It is bounded above by the styloid process of the radius, below by the base of the metacarpal bone of the thumb, upon the radial side by the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis, and upon the ulnar side by the tendon of the extensor secundi internodii pollicis. In it are found the superficial radial vein; the radial artery, as it dips forward into the first interosseous space to form the deep palmar arch; and the base of the first metacarpal bone. The artery gives off in this space the posterior carpal, the first dorsal interosseous, the dorsales pollicis, and the dorsalis indicis artery.

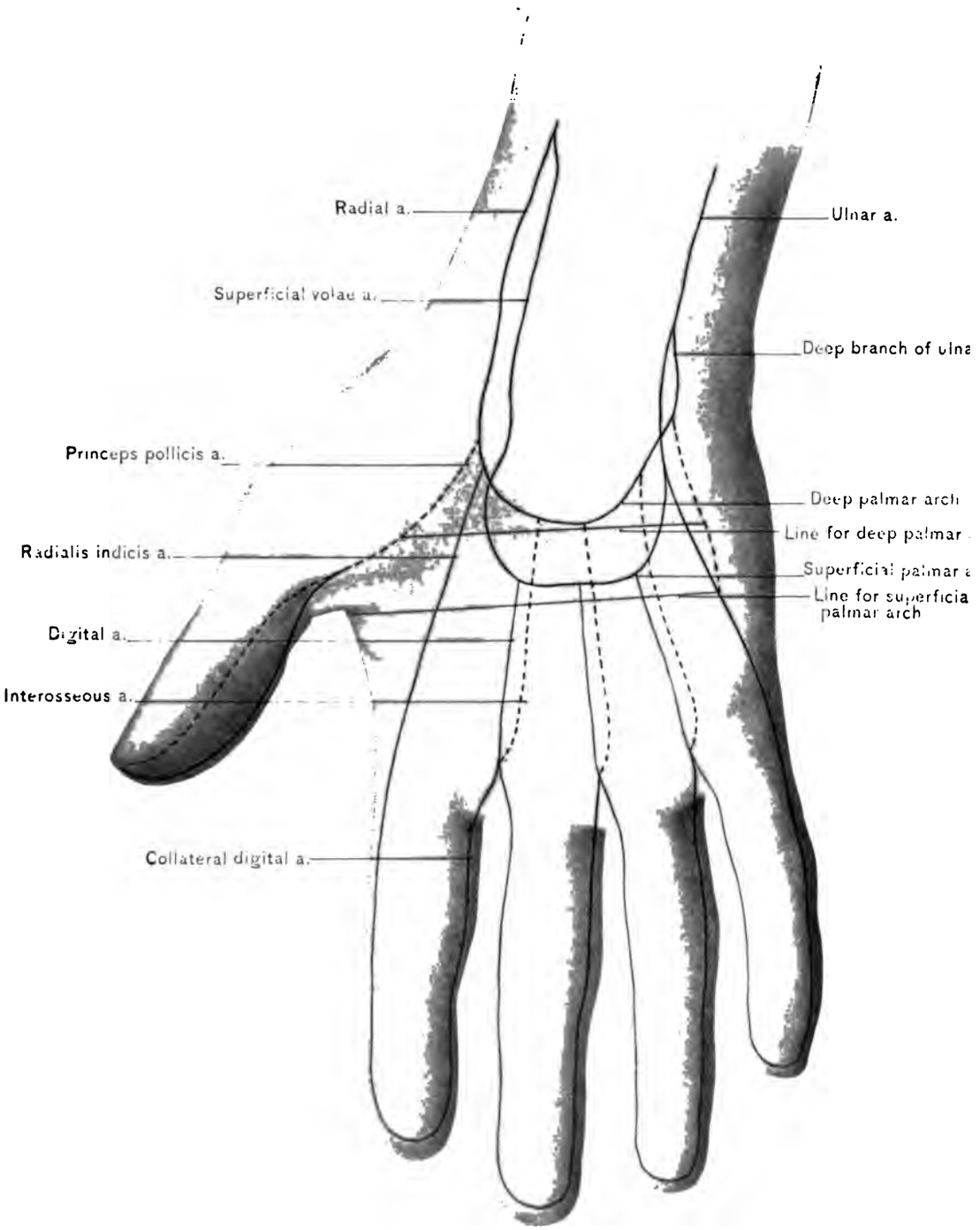
"Tenalgia crepitans" is the name given to a grating sensation present at the back of the wrist in synovitis of the sheaths of the extensor tendons of the fingers—thecitis—and in the dryness accompanying uric acid disease.

THE HAND.

The **palm** of the hand presents two eminences, a depression, and three furrows. The eminences are the thenar—the ball of the thumb—and the hypothenar. The thenar eminence is produced by the short muscles of the thumb, and the hypoth-

PLATE VI.

PLATE V


Radial a.
Ulnar a.
Superficial volae a.
Deep branch of ulna
Princeps pollicis a.
Deep palmar arch
Radialis indicis a.
Line for deep palmar
Superficial palmar a
Line for superficia
palmar arch
Digital a.
Interosseous a.
Collateral digital a.

thenar and hypothenar eminences, and the apex by the junction of the thenar and hypothenar eminences.

The **palmar flexor furrow** is composed of two parts, an ulnar and a radial. The ulnar part (convex upward) extends from in front of the head of the fifth metacarpal bone to the web between the index and middle fingers, and the radial part (convex downward) extends from in front of the head of the metacarpal bone of the index finger to the hypothenar eminence. When the fingers are flexed, the transverse portions of these furrows form a deep fissure with a central interruption. This fissure indicates the position of the heads of the metacarpal bones; the upper limits of the synovial sheaths of the flexor tendons of the index, middle, and ring fingers; the division of the palmar fascia into four slips, and the transverse metacarpal ligament; while a little below it the digital arteries bifurcate into their terminal branches. An *arched furrow* also extends around the base of the thenar eminence from the outer end of the radial portion of the palmar flexor furrow to the base of the thenar eminence. It is placed opposite the carpo-metacarpal joint of the thumb; this relation is analogous to that of the other two furrows to the metacarpo-phalangeal joints. If the metacarpal bone of the thumb be viewed as the first phalanx,—which it is from a developmental point of view,—the analogy is more complete, all three furrows marking the position of the basal articulations of the primary phalanges.

On the palmar surface of the finger there are three transverse furrows; the last two locate the position of the interphalangeal joints, the first furrow being nearly midway between the metacarpo-phalangeal and the first interphalangeal articulations.

With the thumb strongly abducted, a line drawn from its lower border transversely across the palm of the hand represents, for all practical purposes, the lowest point in the course of the superficial palmar arch. A line drawn one-half of an inch to the proximal side of that for the superficial arch, and parallel to it, represents the course of the deep arch.

The **interosseous arteries,** both dorsal and palmar, run along the interosseous spaces, thus making it desirable when opening abscesses of either the front or back of the hand to carry the incision over the metacarpal bones rather than over the interspaces.

The **sesamoid bones of the thumb** lie just beyond the metacarpo-phalangeal joint,—that is, to its distal side,—so that in amputation through the joint the incision into the articulation should be made on the proximal side of these bones.

The **knuckles,** consisting of three rows, are formed by the distal ends of the proximal bones. Thus, the heads of the metacarpals form the first, the distal ends of the first phalanges the second, and the distal ends of the second phalanges the

third, row. To enter the knuckle-joint for amputation the knife should be carried a little in advance of the prominence of the knuckle.

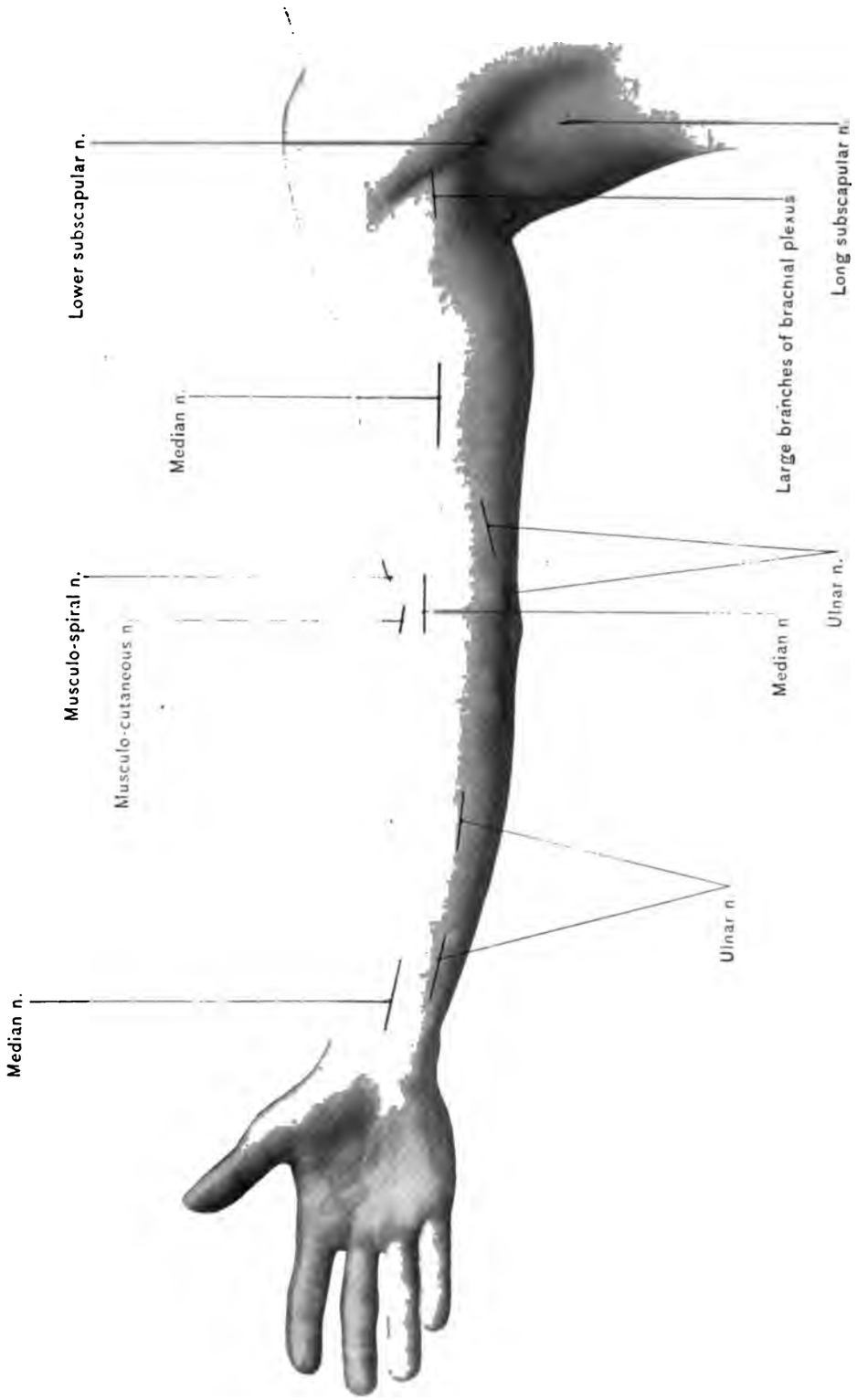
NERVE STRETCHING AND NERVE SECTION have now become so well-recognized and common procedures that the following few instructions may be an aid to the student, both in retaining his knowledge of the anatomic relations and in subsequent practical surgical utility:

The *entire axillary* or *brachial plexus* can be stretched in the axilla through an incision made in the line of the axillary artery. Each branch or cord must be identified, raised upon a blunt hook or aneurysm needle, and pulled with moderate tension in proportion to the size of the nerve being manipulated. The *median nerve* is found upon the outer side of the brachial artery in its upper third, anterior to the artery in its middle third, and on its inner side in its lower third. It can be reached in the lower end of the forearm through an incision parallel with the ulnar border of the flexor carpi radialis tendon, where it will be found between this tendon and the outermost tendon of the flexor sublimis digitorum. The *external cutaneous* or *musculo-cutaneous nerve*, before it pierces the coraco-brachialis muscle, lies upon the outer side of the median nerve, and lower down, between the biceps and brachialis anticus muscles. Upon the outer side of the tendon of the biceps it becomes an occupant of the superficial fascia.

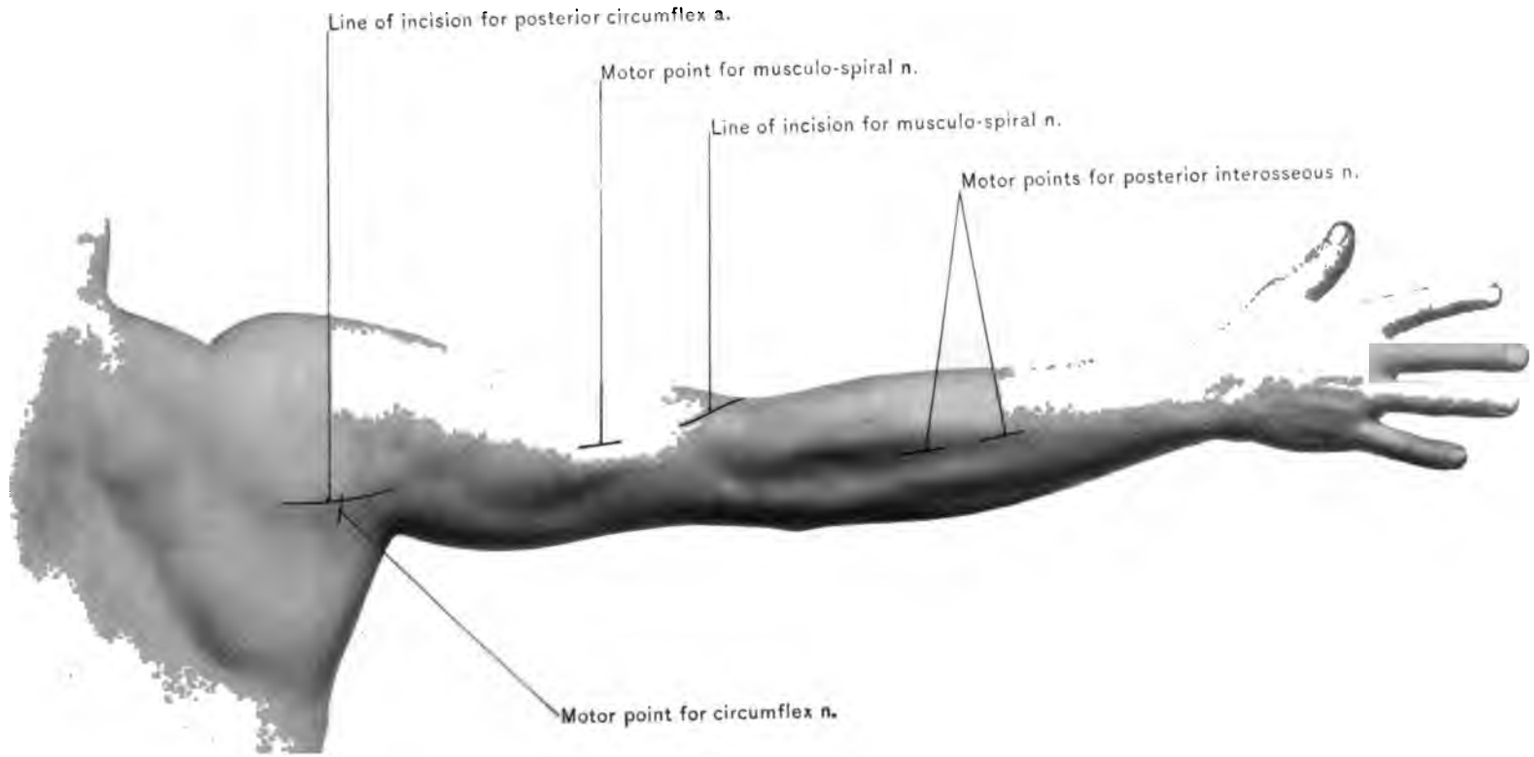
The *internal cutaneous nerve* is found upon the inner side of the brachial artery in the upper third of the arm, and upon the inner side of this vessel and the median nerve in the middle of the arm.

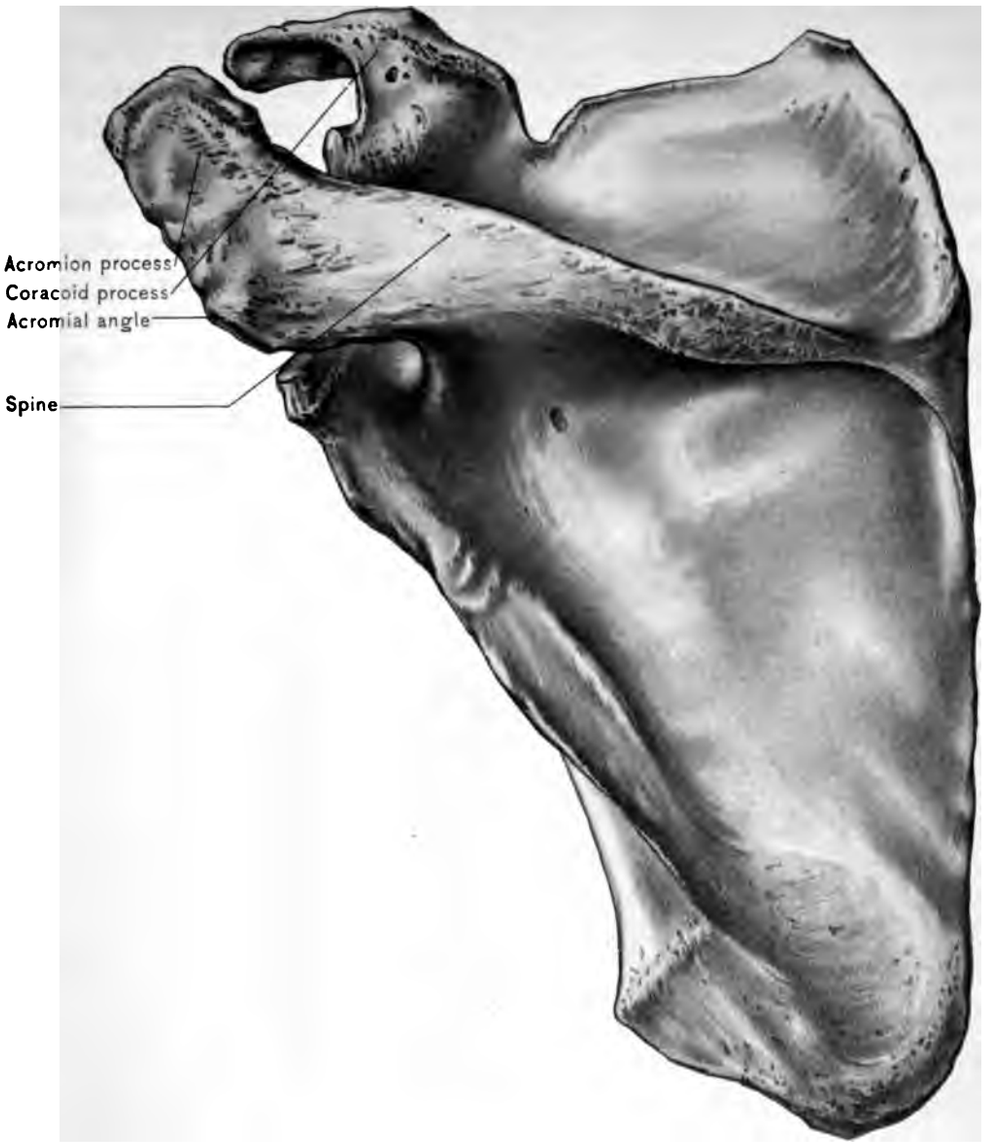
The *ulnar nerve*, in the upper two-thirds of the arm, is on the inner side of the internal cutaneous, and is readily differentiated from it because of its larger size. It is easily found behind the internal condyle, one of the best locations for securing it with little effort and slight danger of confounding it with other structures. It is also readily found in the lower part of the forearm, under the flexor

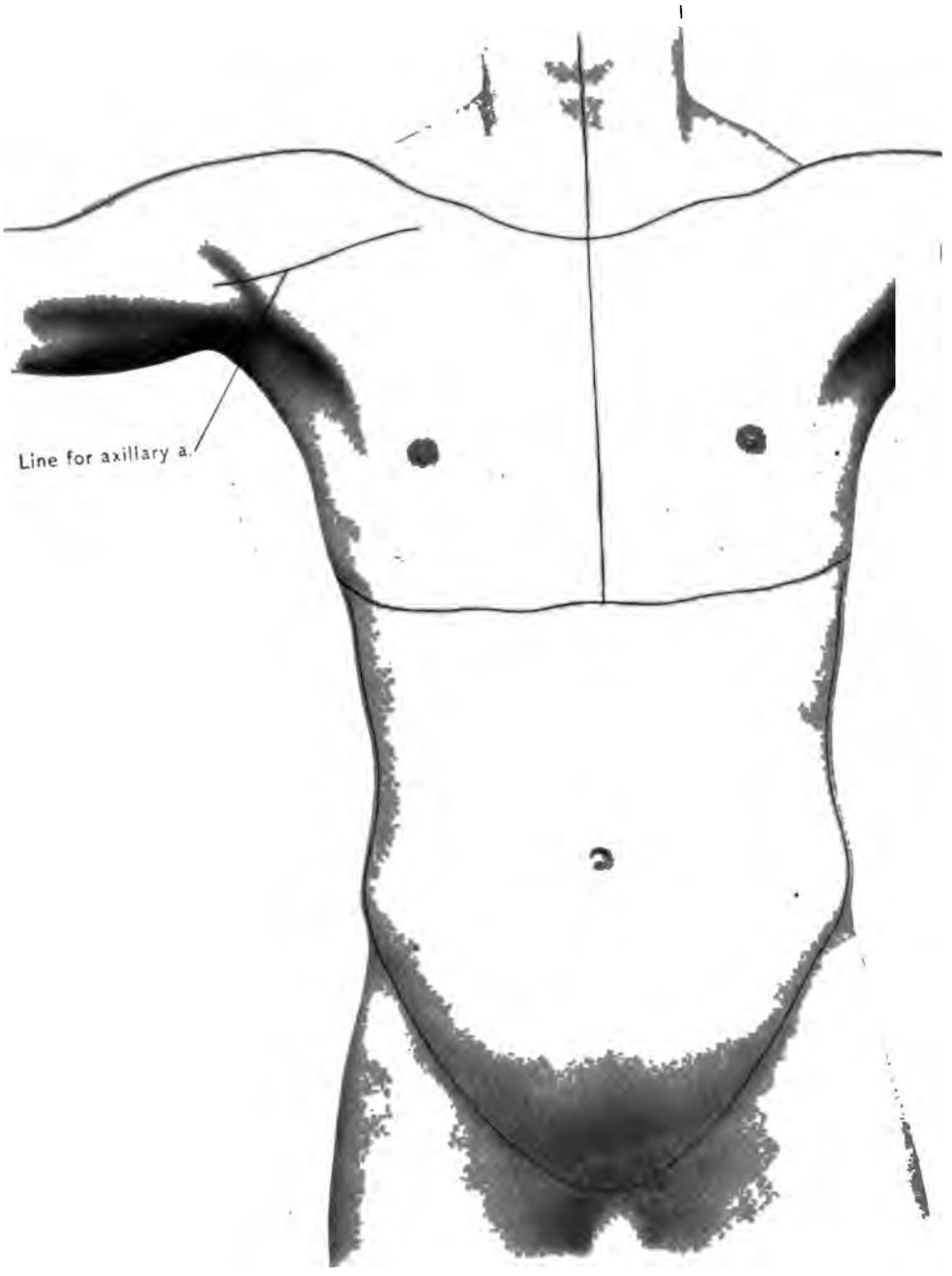
LATE VIII.


Lower subscapular n.
Median n.
Musculo-spiral n.
Musculo-cutaneous n.
Median n.
Ulnar n.
Large branches of brachial plexus
Long subscapular n.
Median n.
Ulnar n.

PLAI


Line of incision for posterior circumflex a.
Motor point for musculo-spiral n.
Line of incision for musculo-spiral n.
Motor points for posterior interosseous n.
Motor point for circumflex n.


Acromion process
Coracoid process
Acromial angle
Spine


Line for axillary a.

arm under the ulnar margin of the supinator longus muscle on the outer side of the radial artery.

The **motor points** are places where the nerves become superficial by perforating the deep fascia, or where they emerge through or between muscles to take a superficial course. It is at these points that response is most readily secured to a concentrated electric current from a small electrode, causing marked tingling and decided muscular contraction with a strength of current that is hardly, or not at all, noticeable at other parts of the cutaneous surface. The points are well shown in Plates VIII and IX.

Measurements of the arm are made from the tip of the acromion, or the angle of junction of the acromion with the spine of the scapula, to the external condyle, and with the forearm extended and supinated from this to the tip of the styloid process of the radius. Each point should be identified and marked with a dot of ink, for the custom of identifying these points while measuring with a tape may cause errors of one-quarter or one-half of an inch in two successive measurements by the same individual. This is particularly important in medico-legal cases.

DISSECTION.—The dissection of the upper extremity includes as much of the front and back of the chest as is connected with the arm, together with the shoulder, axilla, arm, forearm, and hand. Preparatory to making the dissection, the cadaver should be placed upon its back, with the arm at a right angle to the body and resting upon a flat board, to which the hand should be fastened in supination. A block four to six inches in thickness should be placed under the shoulders. For purposes of preservation the part should be bandaged as high as the middle of the arm, preferably with some oiled paper, oiled muslin, or rubber, to prevent drying. This covering should be removed as the dissection progresses and reapplied when discontinuing.

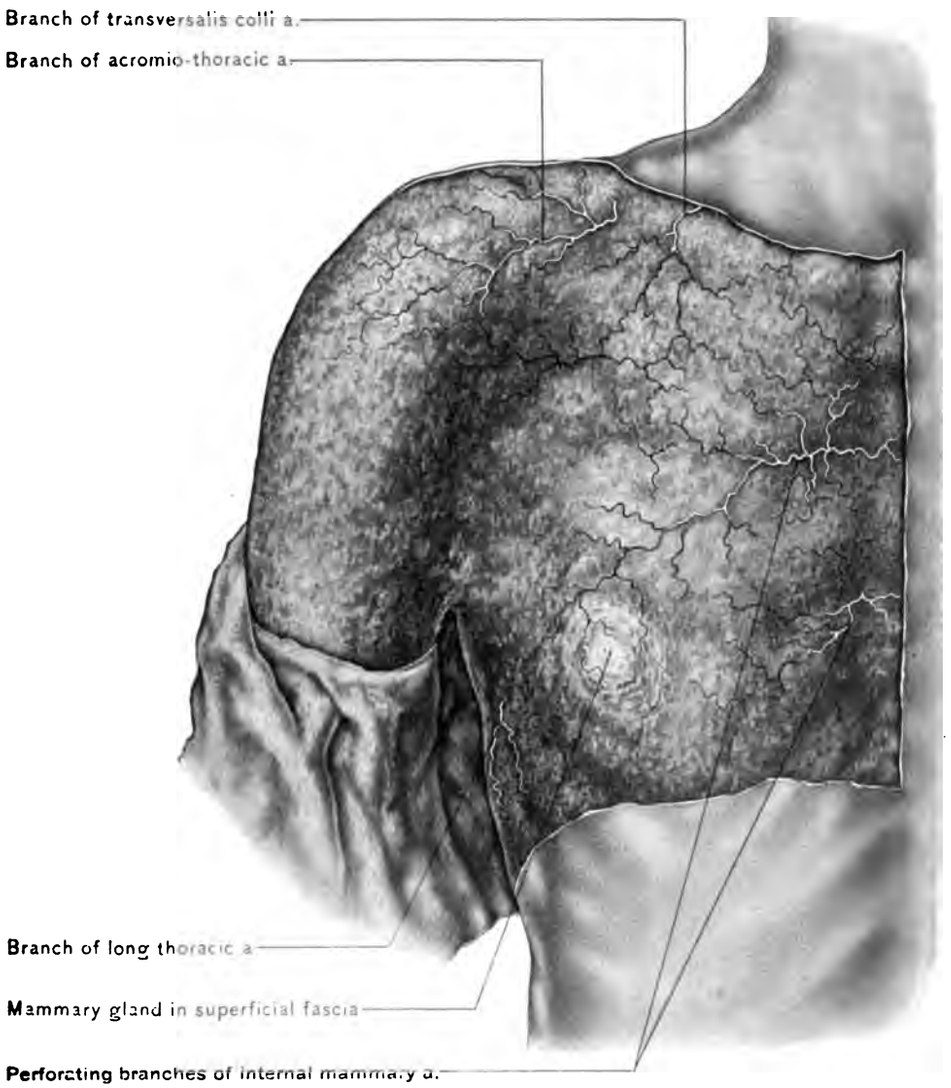
In reflecting the skin it is advisable to make as large flaps as possible. My reason is a two-fold one: first, there is no better covering than the skin to preserve the moisture of the underlying structures; and, second, the dissector is thus enabled to review the surface anatomy of the part, from time to time, and study carefully the relations of the surface markings to the deeper structures. In removing the skin from the front of the chest no more than three incisions are, therefore, advisable: one extending along the middle of the entire length of the sternum, another from the upper end of this incision along the clavicle to its

Now grasp only the skin at the superior sternal angle with a pair of forceps and gradually reflect it by severing its connection to the underlying fascia with a knife; but as soon as enough has been turned back to be readily grasped by the fingers, they should take the place of the forceps, because the work thus becomes easier and is more rapidly and more neatly executed. The superficial fascia and its nerves and vessels thus become exposed, though in the infra-clavicular and shoulder regions there will be seen a thin layer of muscular fibers passing over the clavicle into the neck. This is the origin, or inferior attachment, of the platysma myoides muscle, a superficial structure by which the skin of the neck is moved. It is a remnant of a well-marked and useful structure—the *panniculus carnosus*—a thin layer of muscular fibers existing in the lower animals; it is situated in the superficial fascia, and enables its possessor to shake off flies and other insects by rapid vibratory motions of the hide. It is the underlying red muscular structure which one sees in fancy figures cut in quarters of beef and mutton. A slash of the knife immediately after skinning causes a wide separation of the severed ends of the still warm muscular fibers, which contract as soon as cut.

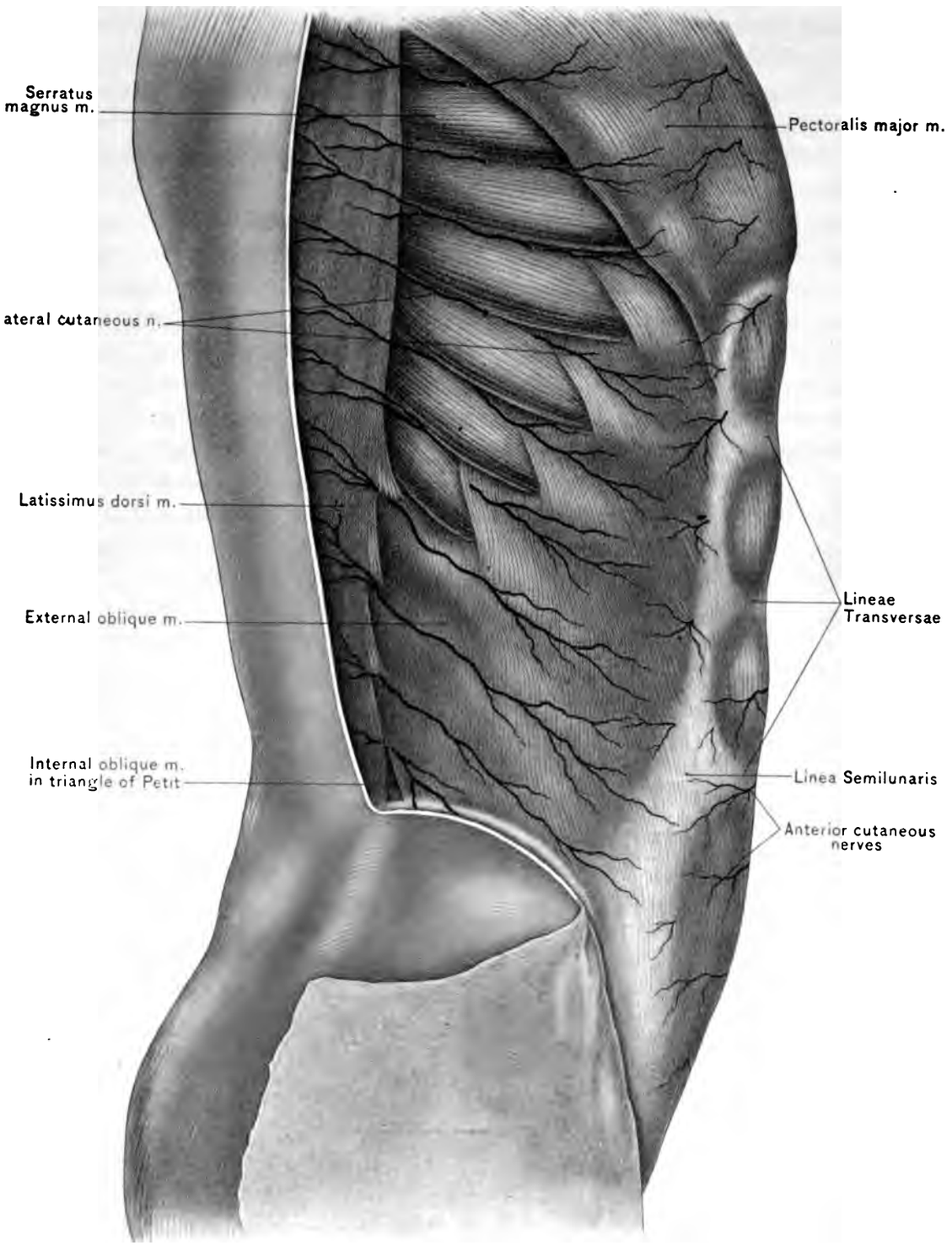
The skin over the sternum is rather thicker than over the lateral regions of the thorax, can not readily be raised up in folds, and retracts considerably when divided. In males it is often covered with a growth of hair. Keloid growths are not uncommonly seen here.

The **superficial fascia** consists of both a *superficial layer* of connective tissue, quite rich in adipose substance, occupying its meshes, and a *deep layer*, which is membranous and resembles the deep fascia to which it is attached. Between the two layers are found the mammary gland, the vessels, and the nerves. Over the sternum the adipose tissue is less abundant than elsewhere in the anterior thoracic region; and in corpulent persons, therefore, the sternal area is relatively depressed. The fascia is firmly adherent to the periosteum of the sternum.

The **vessels of the superficial fascia** are as follows: Five or six *perforating*


Branch of transversalis colli a.
Branch of acromio-thoracic a.
Branch of long thoracic a.
Mammary gland in superficial fascia
Perforating branches of internal mammary a.

LATE XIII.


Serratus magnus m.
Pectoralis major m.
ateral cutaneous n.
Latissimus dorsi m.
External oblique m.
Lineae Transversae
Internal oblique m. in triangle of Petit
Linea Semilunaris
Anterior cutaneous nerves

cephalic vein. The *long thoracic artery* sends branches to the mammary gland and the superficial fascia. All of these vessels supply the fascia and skin of this region, and are accompanied by veins and lymphatics, the latter becoming visible during inflammatory diseases.

The **nerves** in the fascia of this region are branches of the cervical plexus and the intercostals. The *cervical plexus* sends down *inner* or *supra-sternal branches*, which pass over the sternal end of the clavicle to the upper part of the sternal region of the chest; *middle* or *supra-clavicular branches*, to the infra-clavicular region; and *external* or *supra-acromial branches*, to the upper and back part of the shoulder. These three sets comprise the descending branches of this plexus. The *anterior cutaneous branches* of the upper six intercostal nerves pierce the pectoralis major to supply the skin and fascia over this muscle and the region of the sternum. A few twigs from the third and fourth go to the mammary gland. The *lateral cutaneous* nerves, branches of the intercostals, pierce the external intercostal muscles and emerge between the digitations of the serratus magnus muscle. They divide into anterior and posterior branches, the former turning upward over the lower border of the pectoralis major to the fascia and skin of the chest and to the mammary gland, and the posterior passing backward to the dorsum of the trunk over the anterior margin of the latissimus dorsi.

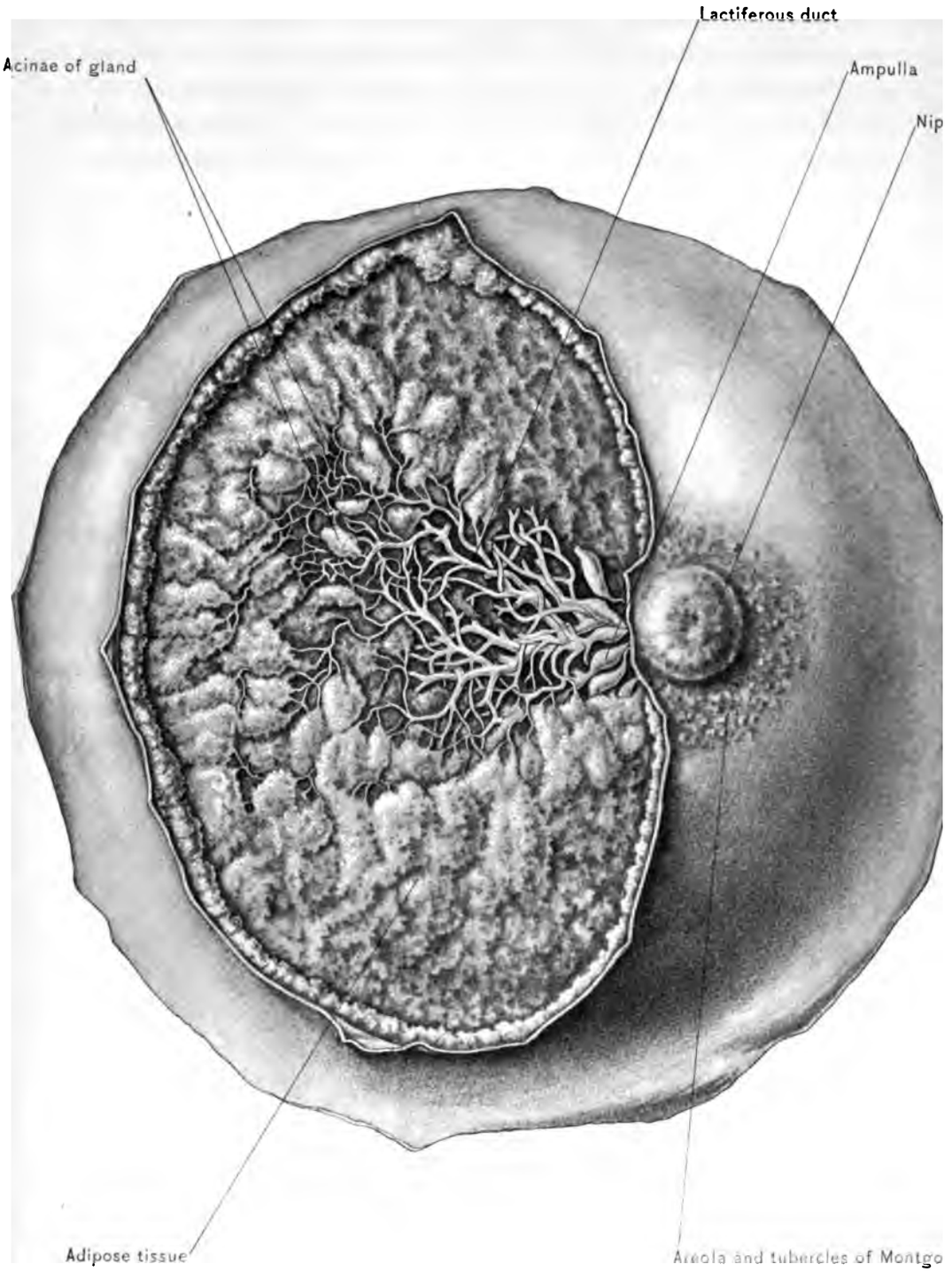
The **lymphatic vessels** of the anterior chest region converge toward the axillary glands, are quite sparse, and in their normal condition are as difficult to distinguish here as elsewhere.

The **mammary glands**—smooth, rounded prominences—form the bust or breasts of women. They are rudimentary in the male, although exceptional instances have been reported of men nursing children from their breasts. They are more or less hemispheroidal, the flat or concave base resting upon the deeper layer of the superficial fascia. They extend from the third to the seventh rib and from the edge of the sternum to the anterior axillary border. Their longest diameter extends upward and outward toward the axilla. The outline of the base of the gland is not circular, but rather triangular, inasmuch as there are two extensions—an upper and a lower—of variable size, one toward the axilla, the other toward the sternum. The upper of these axillary extensions may even curve around the lower border of the great pectoral muscle; furthermore, a com-

being rudimentary in childhood, developing at puberty, and becoming more enlarged during pregnancy, to reach their highest development after childbirth and during lactation. They diminish after lactation, and thus alternately become larger and smaller during successive births, until the child-bearing and suckling periods have been passed, when they atrophy and again assume a rudimentary state.

The mamma is composed of tissue of a glandular, fibrous, and fatty type. The glandular structure is racemose, and consists of small, secreting lobules, with confluent ducts, the lobules uniting to form lobes, each of which has a single main duct terminating in the nipple. There are from fifteen to twenty of these lactiferous or galactophorous ducts. They converge toward the nipple and form under the areola ampullæ or dilatations, which serve as reservoirs for the milk; they again contract as they enter the nipple and open upon the summit by orifices smaller than the ducts themselves. The ducts are composed of connective tissue and longitudinal muscular fibers, and are lined with tessellated epithelium, continuous with the skin externally and with the glandular epithelium internally. The fibrous structure consists of the perimammary investiture of superficial fascia (capsule of the gland) and its intramammary extensions, which form supporting and connecting septa between the lobes of the gland. Some processes of the fascia go to the nipple and skin and are called suspensory ligaments (ligaments of Sir Astley Cooper). The fatty tissue covers the surface of the gland and its component lobes and consists of two portions, the perimammary and interlobar; it does not, however, exist within or immediately beneath the nipple. The amount of the fatty tissue, rather than that of the glandular structure, determines the size of the breast. The deep surface of the capsule of the gland is connected to the deep or pectoral fascia by loose connective tissue, in which a bursa sometimes exists. At times this connective tissue is so loose in female savages, as in the Hottentots, that the glands can be thrown over the shoulder, and a child suckled while being carried upon the

PLATE


Lactiferous duct
Acinae of gland
Ampulla
Nip
Adipose tissue
Areola and tubercles of Montgo

and lactation and have the appearance of subcutaneous tubercles. They secrete a greasy substance to protect the nipple during suckling. These glands may be primarily affected by carcinoma or sarcoma, which may secondarily involve the mammary gland.

The skin of the nipple is thin and very sensitive, and is often the seat of painful and intractable fissures during nursing. Chronic inflammation of the skin of the nipple (eczema) is at times the accompaniment of beginning Paget's disease, mammary epithelioma, and cancer of the breast.

Blood and Nerve Supply.—The mammary gland is nourished by the long thoracic branch of the *axillary* artery, the *anterior intercostal*, and, especially, the *perforating*, branches of the internal mammary artery, and the *intercostal* arteries. The veins accompany the arteries and also form an anastomotic circle about the nipple (*circulus venosus*, Haller), from which large branches carry its contents to the circumference of the gland, whence it is taken to the axillary and internal mammary veins.

The **lymphatic channels** play a conspicuous rôle in inflammatory and neoplastic processes. Most of the mammary lymphatics go to the axillary glands, though a few enter the anterior mediastinal lymphatics, following the mammary branches of the internal mammary artery. When the breasts are unusually large, the lymphatics communicate across the sternum; this is one of the anatomic explanations of the occurrence of cancer in both breasts. In advanced cases of carcinoma of the breast the glands in the infra- and supra-clavicular fossæ often become involved, in addition to the axillary glands. The lymph from the mammary gland first passes into the glands along the anterior fold of the axilla and then into those along the axillary vessels. As metastasis from cancers follows the course of the lymphatics, the glands along the anterior fold are first involved and then those along the axillary vessels are affected. In its course the lymph will, after a time, involve the glands along the subclavian vessels. The anastomosis between the submammary lymphatics and the intramammary lymphatics is so free that the operation for carcinoma of the breast which promises the best results is that which removes the entire gland, the skin wide of the diseased area, totally excises the submammary and paramammary connective tissue, the pectoral fascia, sternal portion of the pectoralis major, the pectoralis minor, the lymphatics and connective tissue of the armpit, deep infraclavicular and subclavian triangles. The lymphatics of the axilla, deep infraclavicular triangle, and subclavian triangle are not necessarily involved through the superficial lymphatic channels, but may be directly infected through the submammary lymphatic vessels. If the axillary vein be wounded in the operation for removal of the breast, a small

ligature; but if the wound be large, the vein must be tied to either side of the rent. When the axillary vein is included in malignant tissue, ligatures should be applied above and below and the involved portion of the vein excised.

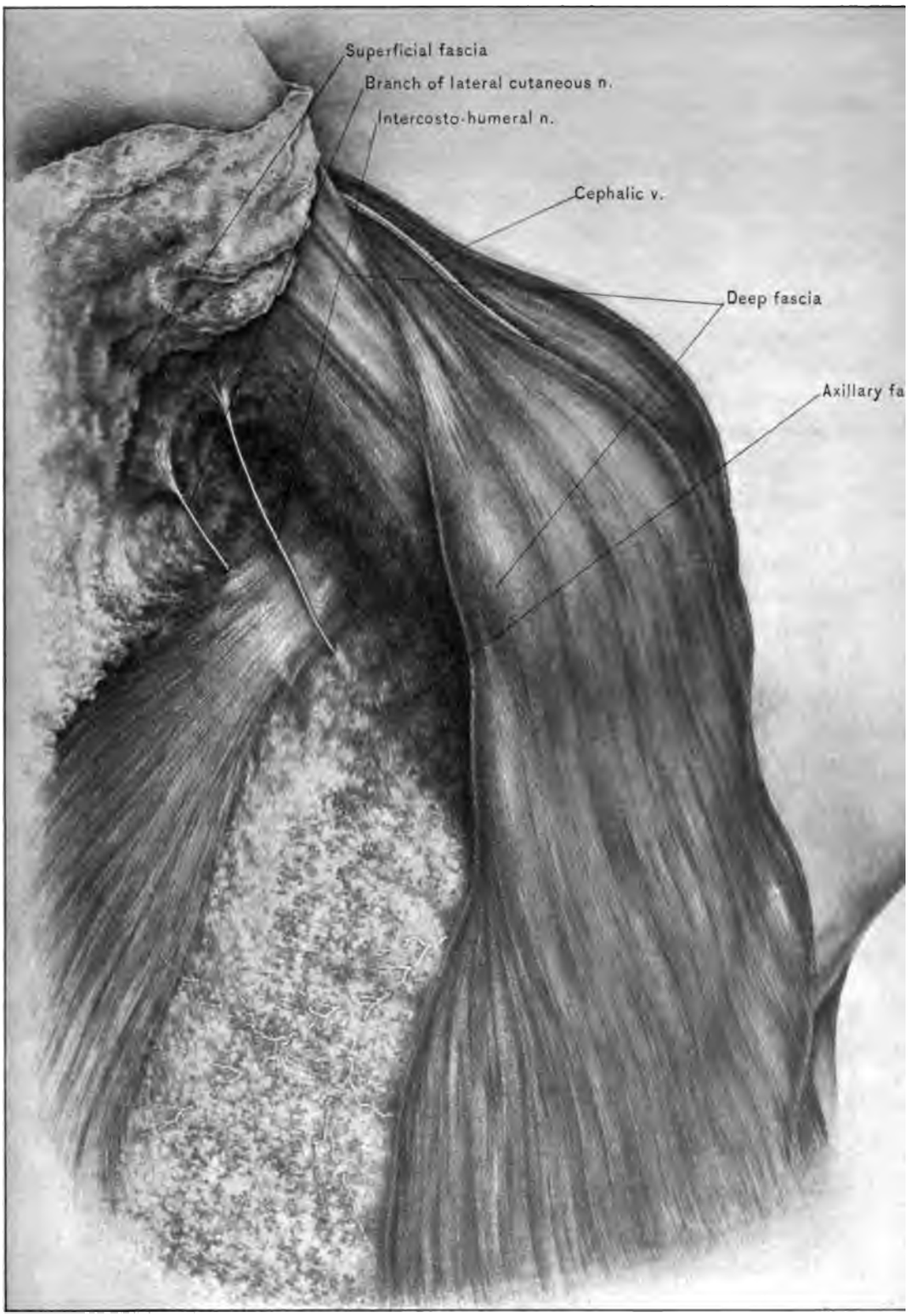
The nerve supply is from the *anterior cutaneous branches* of the third, fourth, and fifth intercostal, the *descending branches* of the cervical plexus, and the *lateral cutaneous branches* of the third, fourth, and fifth intercostals. This arrangement of the nerves explains the pains felt in the shoulder, neck, back, and down the arm in painful breast affections, such as cancer, mastitis, and abscess.

The largest artery divided in excision of the breast is the *long thoracic*, also called *deep external mammary* in contradistinction to the *superficial external mammary*, which is not constant. The superficial external mammary is a branch either of the third division of the axillary or of the first portion of the brachial, and reaches the gland by passing through the superficial fascia of the axilla.

Because of the close relation which this gland bears to the pectoralis major muscle, all movements of the arm affect the gland, more or less. This is not particularly noticeable, ordinarily, but it becomes unpleasantly evident in painful affections of the breast, as in mammary abscess.

Mammary abscess may be confined between the septa of the gland, may be diffused throughout the organ, or may occur in the submammary connective tissue; in this last event it will most likely point at the anterior fold of the axilla. Incisions into the breast should be made toward the nipple, so as not to sever the lactiferous ducts which converge toward this point. After opening an abscess of the mammary gland, the fibrous septa of the abscess should be broken down in order that perfect drainage may be obtained. After all operations upon the mammary gland, and in the treatment of inflammatory affections of the gland, the whole upper extremity should be bandaged to the chest as in fractured clavicle, so that movements of the arm and pectoralis major will not prevent rest of the part. Enlargement of the bursa under the breast would constitute a submammary cyst. In long-standing scirrhus (hard cancer) of this gland the nipple is retracted and the skin dimpled, because of traction by the fibrous septa and lactiferous ducts.

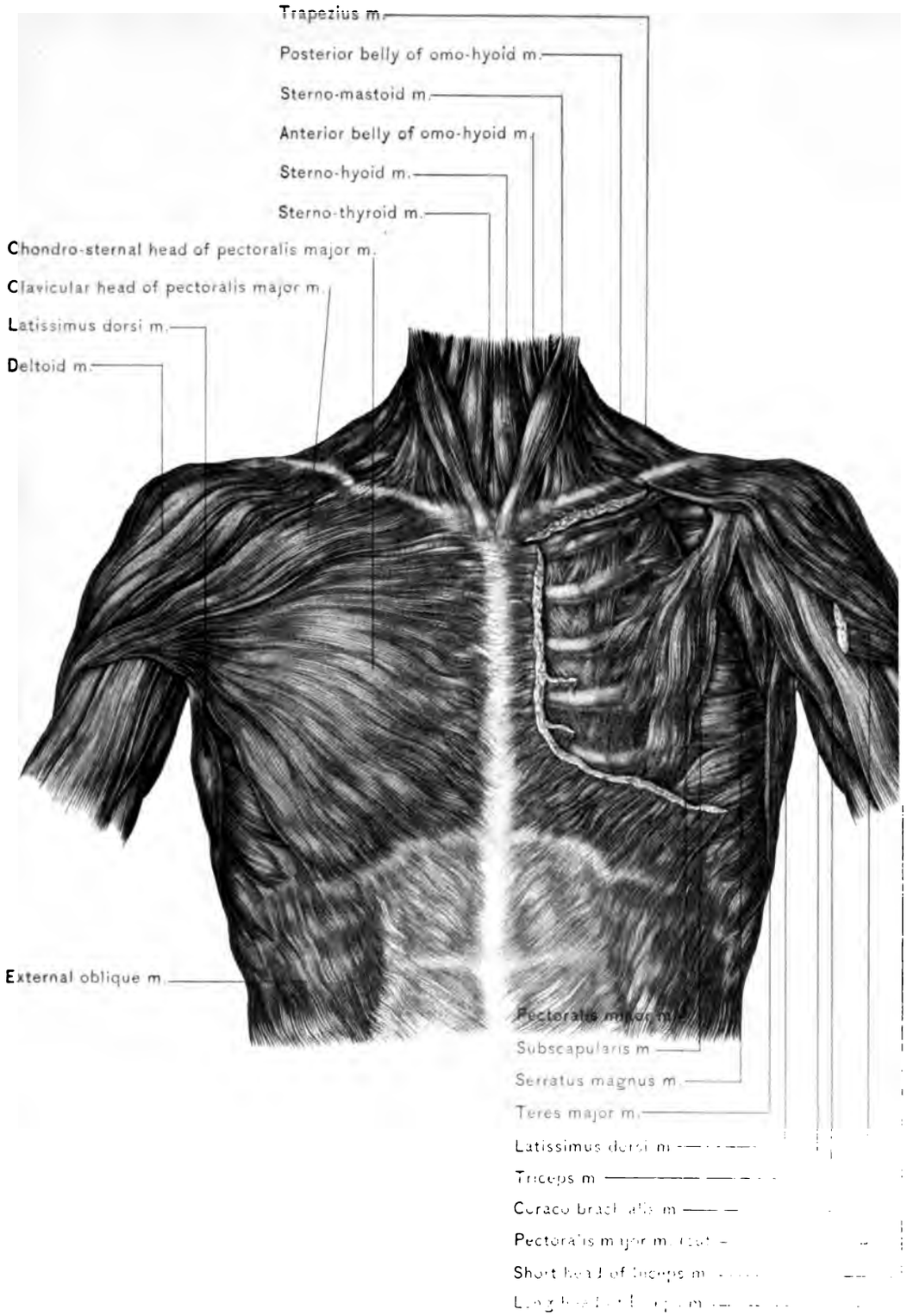
In *detecting adhesions* between the mammary gland and the pectoralis major, as in carcinoma of the breast, the gland should be moved in the direction of the fibers of that muscle; for if the gland is moved in a direction which is across that of the


Superficial fascia
Branch of lateral cutaneous n.
Intercosto-humeral n.
Cephalic v.
Deep fascia
Axillary fa

the lateral half of the entire length of the sternum, except below the attachment of the seventh costal cartilage; from the cartilages of the true ribs, excepting frequently either the first or the seventh, or both; from the sternal end of the sixth rib; and from the aponeurosis of the adjacent portion of the external oblique. From this extensive origin the fibers converge upon the front of the arm, forming a flat tendon about two inches in length, which is inserted into the anterior bicipital ridge of the humerus. The lowermost fibers of origin of this portion have the highest insertion on the ridge, and the uppermost fibers have the lowest. Thus, the most inferior fibers are overlapped near their insertion by the middle fibers, and these in turn by the upper. The clavicular fibers pass downward and outward, the central fibers horizontally outward, and the lower fibers upward and outward. The anterior layer of the doubled tendon of insertion is thicker than the posterior, and receives the fibers of the clavicular and upper chondro-sternal portions, the posterior portion receiving the remaining fibers from the lower half of the muscle. The tendon of insertion is connected with that of the deltoid. It sends a prolongation upward over the bicipital groove to the greater tuberosity, thus binding down the long head of the biceps, another backward to line the groove, and still another to the deep fascia of the arm.

The chondro-sternal portion lies upon the sternum, ribs, and costal cartilages, the intercostal muscles, the pectoralis minor, part of the serratus magnus, and the deep layer of the deep fascia; the clavicular portion lies in front of the costo-coracoid membrane and the structures piercing this membrane. The pectoralis major, pectoralis minor, and deep layer of the deep fascia form the anterior axillary wall. Between the clavicular portion of the pectoralis major and the anterior edge of the deltoid is the delto-pectoral sulcus, or cephalic groove, which accommodates the cephalic vein and the descending or humeral branch of the acromio-thoracic artery. Internally, in some muscular individuals the fibers of the pectoralis major decussate with those of its fellow of the opposite side. Occasionally, muscular fibers are found along the sternum, from the manubrium above to the sheath of the rectus below, and form the *rectus sternalis muscle*. The lower edge of the pectoralis major forms the anterior axillary margin and, with the latissimus dorsi, converges toward the outer part of the space.

The cellular interval between the chondro-sternal and clavicular portions of


Trapezius m.
Posterior belly of omo-hyoid m.
Sterno-mastoid m.
Anterior belly of omo-hyoid m.
Sterno-hyoid m.
Sterno-thyroid m.
Chondro-sternal head of pectoralis major m.
Clavicular head of pectoralis major m.
Latissimus dorsi m.
Deltoid m.
External oblique m.
Subscapularis m.
Serratus magnus m.
Teres major m.
Latissimus dorsi m.
Triceps m.
Coraco brachialis m.
Pectoralis major m.
Short head of biceps m.
Long head of biceps m.

rotator of the humerus. The clavicular portion aids the anterior fibers of the deltoid in elevating the arm and drawing it forward, while the lowermost fibers of the chondro-sternal portion draw the arm downward and forward. The pectoralis major is a hugging muscle. If the arm be fixed, its action is reversed. It then would help to elevate the body suspended by the arms, would elevate the body in dipping between parallel bars, and would be a powerful aid in difficult respiration when the arms are fixed. It reaches a remarkable development in winged animals, in which its size may be inferred from the thickness of their breasts. The pectoralis major is often the seat of carcinomatous deposits in cases of malignant disease of the breast; and, in such cases, the surgeon does not hesitate to remove a part or the whole of the muscle. In the most radical operation for mammary cancer the chondro-sternal portion of the muscle is always removed. After this operation hypertrophy of the clavicular portion of the pectoralis major and the anterior part of the deltoid compensates for the loss of the chondro-sternal portion of the pectoralis major.

BLOOD SUPPLY.—Nourishment is supplied to this muscle by branches of the axillary and internal mammary arteries, especially the acromio-thoracic and long thoracic branches of the axillary which ramify in the anterior pectoral region.

NERVE SUPPLY.—Its nerves are the external and internal anterior thoracic.

DISSECTION.—The next step in the dissection is to detach the clavicular portion of the pectoralis major from the clavicle and displace it downward and outward, when will be seen a triangular-shaped space, the floor of which is formed by the deep pectoral or clavi-pectoral fascia. This triangular-shaped space is the superficial infra-clavicular triangle—superficial in contradistinction to a still deeper one, the *deep infra-clavicular triangle*—seen after the removal of the clavi-pectoral fascia.

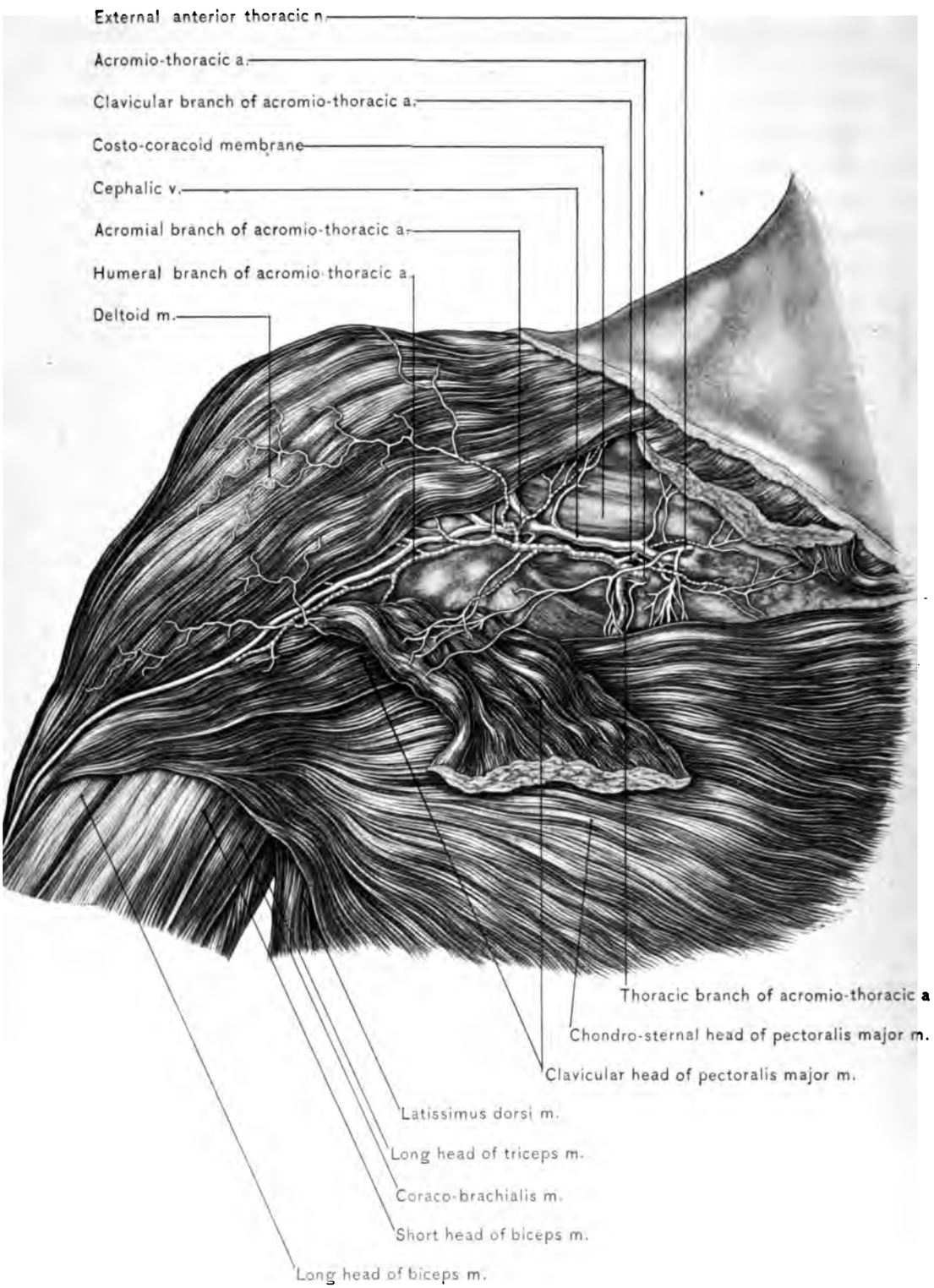
The **superficial infra-clavicular triangle.**—The base of the superficial infra-clavicular triangle is directed outward and is formed by the anterior border of the deltoid muscle; the apex is directed inward and lies at the junction of the clavicle with the sternum. It is bounded above by the inner half of the clavicle, and below by the upper edge of the sternal portion of the pectoralis major. Its roof is formed by the clavicular portion of the pectoralis major; its floor, by the clavi-

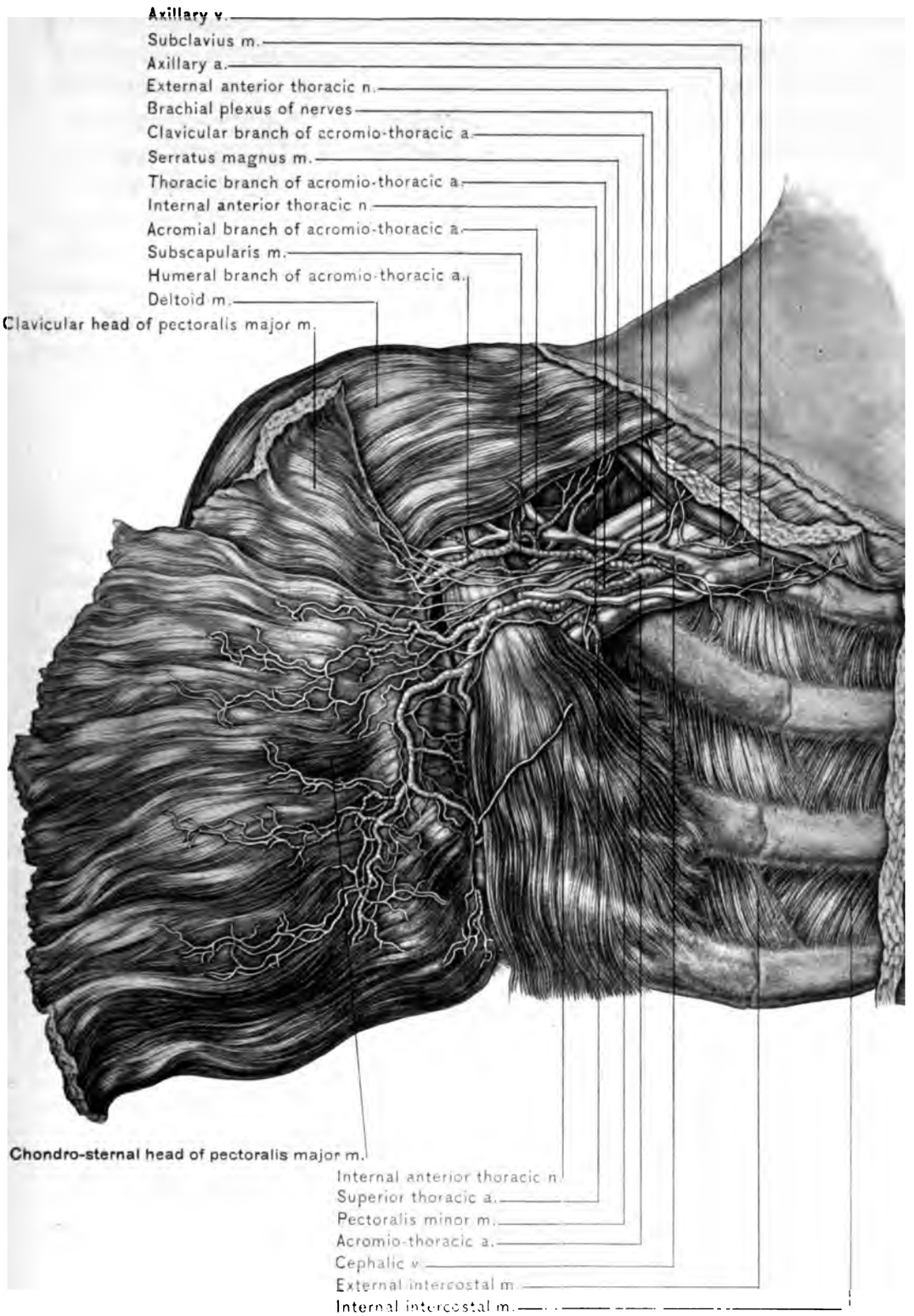
attached to the upper surface of the coracoid process; internally, it blends with the intercostal fascia covering the upper two intercostal spaces; below, it divides along the upper border of the pectoralis minor to invest this muscle. From the lower border of the pectoralis minor it descends as a single layer to join the superficial layer of the deep or pectoral fascia along the lower margin of the pectoralis major, forming the *axillary fascia.* As previously described, it forms the floor of the superficial infra-clavicular triangle. It is denser externally at its attachment to the coracoid process than internally, where it blends with the fascia covering the first two intercostal spaces. It also blends with the sheath of the axillary vessels. The clavi-pectoral fascia is sometimes spoken of as the *suspensory ligament of the axilla,* since by its connection with the fascial sheath of the pectoralis minor it suspends the axillary fascia (floor of axilla), thus forming the hollow of the arm-pit.

The **costo-coracoid membrane** is that portion of the clavi-pectoral fascia which fills the interval between the clavicle and upper border of the pectoralis minor muscle. It is denser than the lower part of the clavi-pectoral fascia, and is pierced by the *cephalic vein, acromio-thoracic artery and vein,* the *external anterior thoracic nerve,* and sometimes by a branch of the *superior thoracic artery.*

Considerable importance attaches to the arrangement of the deep or pectoral fascia because of possible purulent collections in this region. Such a collection situated behind the pectoralis major, or between it and the pectoralis minor, would point either at the anterior border of the axilla or under the clavicle in the upper end of the delto-pectoral sulcus. If, however, it were situated behind the pectoralis minor muscle and the deep layer of the deep fascia, it would either remain confined in the axillary space and point at the floor of the arm-pit or extend upward into the neck in the direction of least resistance and point above the clavicle.

ATE XVIII.


External anterior thoracic n.
Acromio-thoracic a.
Clavicular branch of acromio-thoracic a.
Costo-coracoid membrane
Cephalic v.
Acromial branch of acromio-thoracic a.
Humeral branch of acromio-thoracic a.
Deltoid m.
Thoracic branch of acromio-thoracic a
Chondro-sternal head of pectoralis major m.
Clavicular head of pectoralis major m.
Latissimus dorsi m.
Long head of triceps m.
Coraco-brachialis m.
Short head of biceps m.
Long head of biceps m.


Axillary v.
Subclavius m.
Axillary a.
External anterior thoracic n.
Brachial plexus of nerves
Clavicular branch of acromio-thoracic a.
Serratus magnus m.
Thoracic branch of acromio-thoracic a.
Internal anterior thoracic n.
Acromial branch of acromio-thoracic a.
Subscapularis m.
Humeral branch of acromio-thoracic a.
Deltoid m.
Clavicular head of pectoralis major m.
Chondro-sternal head of pectoralis major m.
Internal anterior thoracic n.
Superior thoracic a.
Pectoralis minor m.
Acromio-thoracic a.
Cephalic v.
External intercostal m.
Internal intercostal m.

toralis major and deltoid muscles, the anterior lamella of the costo-coracoid membrane being between; and behind, with the posterior layer of the costo-coracoid membrane, the subclavian vessels, and brachial plexus of nerves.

BLOOD SUPPLY.—From the clavicular branch of the acromio-thoracic artery.

NERVE SUPPLY.—A filament from the cord formed by the fifth and sixth cervical nerves.

ACTION.—It depresses the shoulder by pulling the clavicle downward and forward. It also draws the clavicle inward, holding the inner extremity of the bone against the sternum.

DISSECTION.—Push the subclavius muscle upward and divide the posterior layer of the costo-coracoid membrane; then divide the costo-coracoid membrane at its attachments to the coracoid process and the upper two intercostal spaces, and dissect it from the structures which pierce it, leaving the latter intact. This will expose to view the deep infra-clavicular triangle.

The **deep infra-clavicular triangle.**—The base of the deep infra-clavicular triangle is directed inward, and is formed by the line of junction of the upper two ribs with their costal cartilages; the apex is directed outward, toward the coracoid process. It is bounded above by the inner half of the clavicle, and below by the upper border of the pectoralis minor. Its roof is formed by the costo-coracoid membrane and its floor by the upper two ribs and intercostal muscles, the serratus magnus, and the subscapularis muscle. It will be seen that the subclavius muscle, since it is ensheathed by the costo-coracoid membrane, must necessarily be found in the floor of the superficial and in the roof of the deep infra-clavicular triangle. The contents of the deep triangle are the *third portion of the axillary vein*, the *first portion of the axillary artery*, the *superior thoracic and acromio-thoracic arteries and veins*, the *terminal portion of the cephalic vein*, the *external and internal anterior thoracic nerves*, the *cords of the axillary or brachial plexus*, and the *posterior or long thoracic nerve*. These structures will be described under the dissection of the axilla, as they can be studied to better advantage at that time.

DISSECTION.—The remaining or chondro-sternal portion of the pectoralis major should now be severed in the middle and reflected, when will be exposed the *pectoralis minor* enveloped by the deep layer of the deep or pectoral fascia. The *internal anterior thoracic nerve* should be observed as it passes from the pectoralis minor to

muscle. It lies behind, and in contact with, the pectoralis major, between the two lamellæ of the deep layer of the pectoral fascia, and immediately in front of the axillary contents. Its upper and lower margins divide the axillary artery, over which it passes, into three parts, the first portion being above, the second behind, and the third below, the muscle.

BLOOD SUPPLY.—From the superior or short thoracic and long thoracic arteries, which pass along its upper and lower borders respectively.

It receives its NERVE SUPPLY from the internal anterior thoracic nerve, which pierces it to enter the under surface of the pectoralis major.

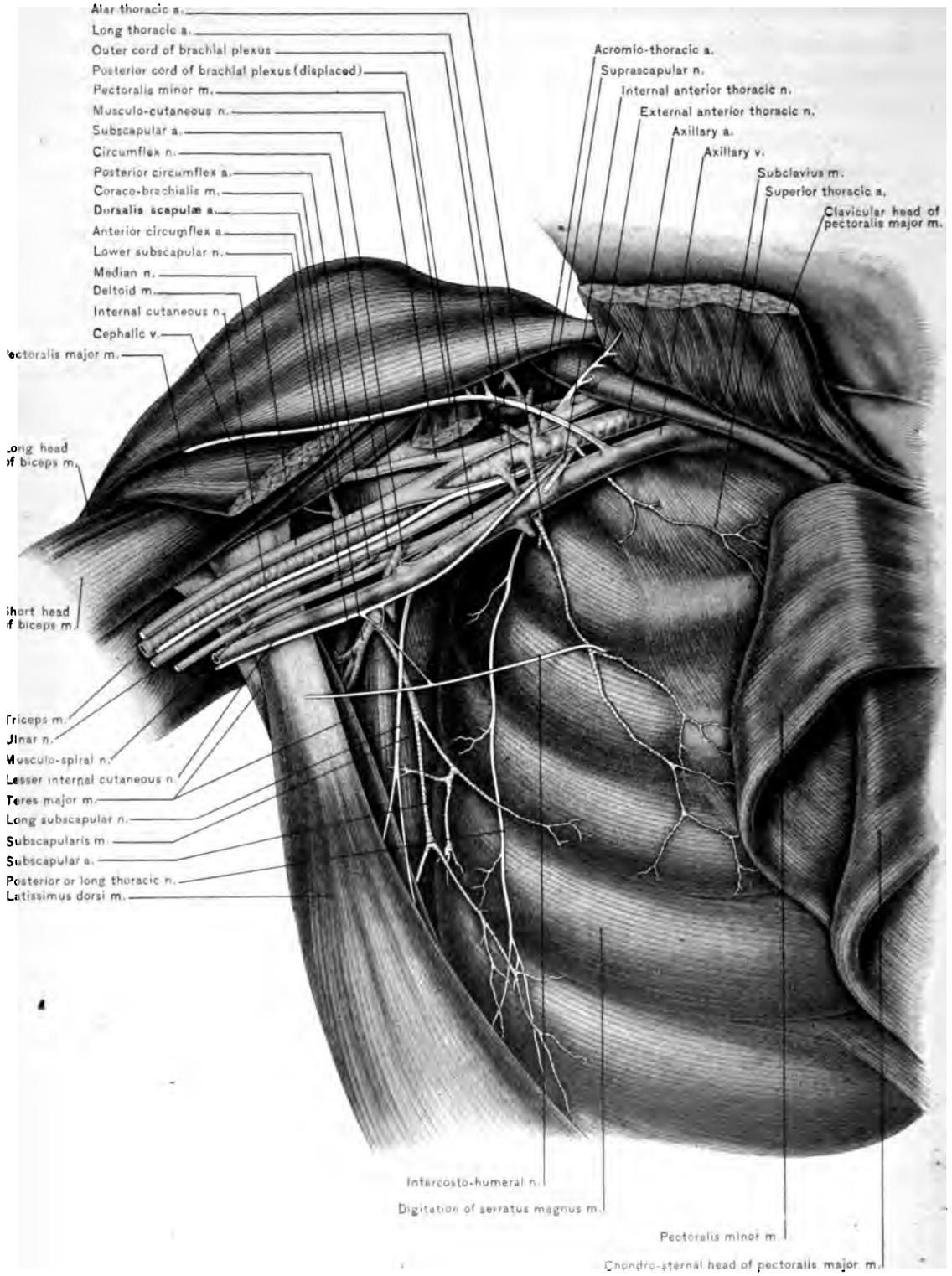
ACTION.—It draws the shoulder downward and forward, but does not draw it inward, as is so generally stated, because, though tending to do so, the clavicle prevents. If the shoulder were fixed well forward, it could act as a powerful inspiratory muscle.

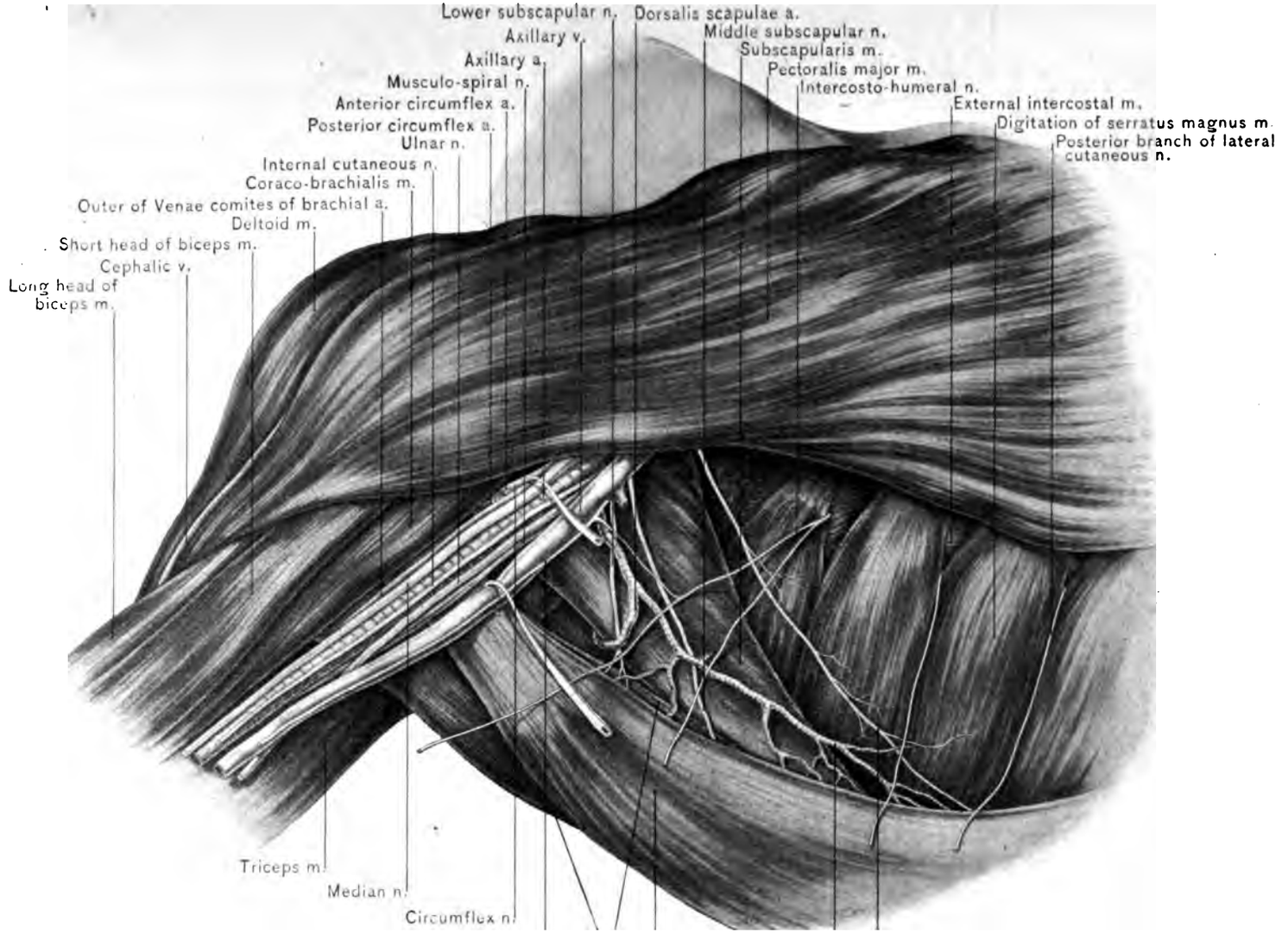
DISSECTION.—This muscle should now be severed through its middle and reflected as far as its attachments, thus exposing the whole axilla to view. Upon the opposite side of the body the axillary contents should be dissected from below upward without disturbing the pectoral muscles, access to the axilla being gained through its base, which is the axillary fascia. It is by this latter route that the surgeon enters in nearly all axillary operations. The study of the axillary contents from these two different directions forms the best method of practically familiarizing the student with their intricate relations.

The **axillary fascia.**—The layer of fascia inclosing the pectoralis minor joins the layer covering the pectoralis major along the lower or axillary border of the latter muscle; by this union is formed the axillary fascia. It is a dense membrane which extends from the lower border of the pectoralis major backward to the latissimus dorsi muscle, and forms the floor of the axilla—outward to become continuous with the deep fascia of the arm, and inward to blend with the deep fascia of the chest. Where it meets the latissimus dorsi (posterior border of the axilla), it divides into two layers, which ensheath that muscle and become continuous with the deep fascia of the back.

The **axilla,** or **arm-pit,** is a pyramidal-shaped space or recess, situated between

PLATE XX.


Alar thoracic a.
Long thoracic a.
Outer cord of brachial plexus
Posterior cord of brachial plexus (displaced)
Pectoralis minor m.
Musculo-cutaneous n.
Subscapular a.
Circumflex n.
Posterior circumflex a.
Coraco-brachialis m.
Dorsalis scapulæ a.
Anterior circumflex a.
Lower subscapular n.
Median n.
Deltoid m.
Internal cutaneous n.
Cephalic v.
ectoralis major m.
ong head
f biceps m.
hort head
f biceps m.
riceps m.
Ulnar n.
Musculo-spiral n.
Lesser internal cutaneous n.
Teres major m.
Long subscapular n.
Subscapularis m.
Subscapular a.
Posterior or long thoracic n.
Latissimus dorsi m.
Acromio-thoracic a.
Suprascapular n.
Internal anterior thoracic n.
External anterior thoracic n.
Axillary a.
Axillary v.
Subclavius m.
Superior thoracic a.
Clavicular head of pectoralis major m.
Intercosto-humeral n.
Digitation of serratus magnus m.
Pectoralis minor m.
Chondro-sternal head of pectoralis major m.


Lower subscapular n.
Dorsalis scapulae a.
Axillary v.
Middle subscapular n.
Axillary a.
Subscapularis m.
Musculo-spiral n.
Pectoralis major m.
Anterior circumflex a.
Intercosto-humeral n.
Posterior circumflex a.
External intercostal m.
Ulnar n.
Digitation of serratus magnus m.
Internal cutaneous n.
Posterior branch of lateral cutaneous n.
Coraco-brachialis m.
Outer of Venae comites of brachial a.
Deltoid m.
Short head of biceps m.
Cephalic v.
Long head of biceps m.
Triceps m.
Median n.
Circumflex n.

PLATE

bleeding to alarm the operator and lead him to fear that he has wounded a large branch within the axilla.

The *contents* of the axilla are the axillary vein and its branches; the axillary artery and its branches; the axillary or brachial plexus of nerves, and most of its branches; the lateral cutaneous branches of the intercostal nerves, that of the second being known as the intercosto-humeral; the posterior or long thoracic nerve; three chains of axillary lymphatic glands, and a large quantity of areolar tissue and fat.

DISSECTION.—Upon the side of the body on which the anterior axillary wall has been reflected the areolar tissue and fat should be removed from the other structures in the axilla in the order in which they have been enumerated, while upon the opposite side the space should be dissected from below upward.

The axillary vessels are inclosed by a *sheath* derived from the prevertebral layer of the deep cervical fascia, the anterior wall of which is reinforced by the costo-coracoid membrane. The sheath should be removed in order that the vessels may be more clearly exposed.

The **axillary vein,** the vessel accompanying the axillary artery, is the continuation of the basilic vein. It commences at the lower border of the tendon of the teres major and passes upward along the outer wall of the axilla as far as the lower border of the first rib, where it becomes the subclavian vein. It lies to the inner or thoracic side of the axillary artery. The axillary vein receives the cephalic vein and branches corresponding to those of the axillary artery, with the exception of those of the circumflex arteries, which may enter either the subscapular vein or one of the venæ comites of the brachial artery, or the cephalic vein. In the upper part of the axilla the relation between the axillary vein and the axillary artery is more intimate than it is in the lower part. (See Relations of the Axillary Artery, p. 82.) The axillary vein, like the artery, may be said to consist of three portions—namely, the first, the second, and the third. The first and third portions of the vein correspond to the third and first portions of the artery respectively.

The axillary vein is more likely to be wounded than the axillary artery, as it lies nearer the surface. When the vein is engorged with blood, it sometimes comes into sight sooner than we expect; and therefore it behooves the operator to be very careful. On account of the size of the axillary vein and its close proximity to the heart, in wounds of the vessel there is danger of air entering the circulation. The

deleterious effects, it is, nevertheless, better to err on the side of safety; consequently, when large venous trunks are divided, as in amputation, they, as well as the arteries, should be separately ligated. The danger in including the artery and the vein in the same ligature is the establishment of an ulcerative communication between the vessels, and a consequent arterio-venous aneurysm. Again, the divided vein, when not tied, offers an avenue for the introduction of septic matter into the circulation.

Pressure upon the axillary vein, as in forward dislocation of the humerus, from axillary tumors, a crutch, an axillary pad, or enlargement of the lymphatic glands, may cause edema of the arm and forearm. Edema of the arm associated with carcinoma of the breast is a grave symptom, because it indicates involvement of the deep lymphatics, which are in relation with the axillary vessels. Edema appearing shortly after removing the fat and lymphatics of the axilla in excision of the breast is due to a phlebitis, or loss of support previously given the vein by the fat, lymphatics, and pectoral muscles.

When opening the arm-pit for the purpose of excising a growth or removing enlarged glands, the incision I recommend is one made along the center of the arm-pit, extending far enough into the arm to expose the first portion of the axillary vein. The dissection should then be made from without inward or away from the axillary vein. By following this method there will be less risk of wounding the vein than when working from within outward or from below upward. The practice of removing enlarged glands with the finger, used as a hook, through a comparatively small opening in the base of the axilla is dangerous.

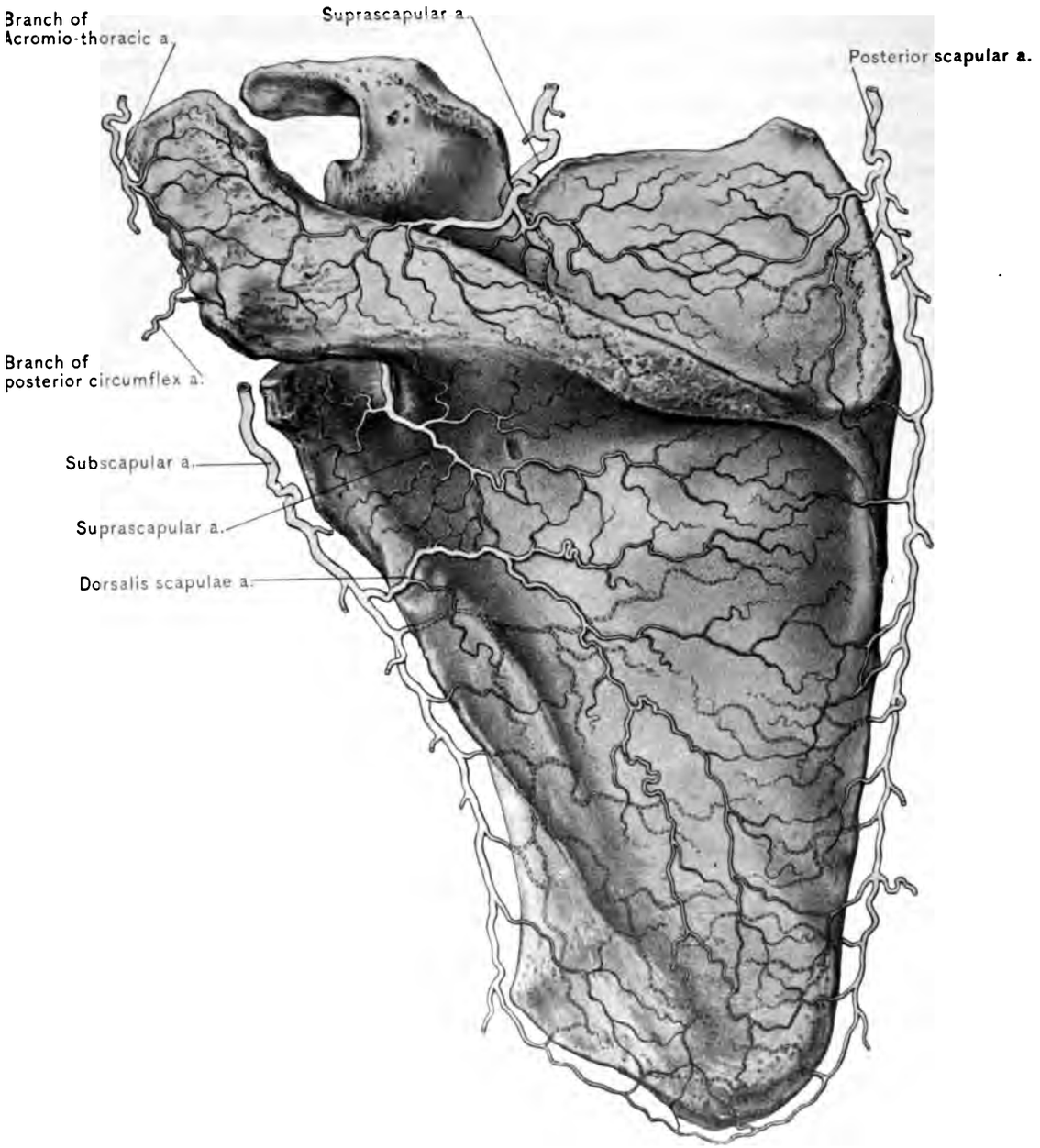
The **axillary artery,** the continuation of the subclavian, commences at the lower border of the first rib. It passes downward and outward through the apex, along the outer wall of the axilla, beneath the greater and lesser pectoral muscles, and along the inner border of the coraco-brachialis to the lower border of the tendon of the teres major, where it becomes the brachial. The course of the vessel through the axilla varies with the relation of the arm to the body. With the

As the relations of the artery vary in passing through the axilla, it is, for convenience of description, divided into three portions—the first, second, and third.

The *first portion* extends from the lower border of the first rib to the upper border of the pectoralis minor; the *second portion*, the shortest, lies behind that muscle; the *third portion*, the longest, extends from the lower border of the pectoralis minor to the lower border of the tendon of the teres major. This last portion of the artery, as it is most accessible, is known as the point of election for ligation, and a ligature applied to this part of the vessel can be made to encircle it further away from the branches than in either the first or second portions, and thereby interfere less with the establishment of the collateral circulation. This portion of the vessel offers a favorable point for digital *compression* against the upper end of the humerus or with the finger inserted into the axilla, against the axillary or external margin of the scapula. A muscular slip, passing from the latissimus dorsi to join the pectoralis major, coraco-brachialis, or biceps muscle, and crossing the third portion of the axillary artery, is sometimes present. This should be borne in mind, and the slip should not be mistaken for the coraco-brachialis.

THE FIRST PORTION.—In front of this portion are the external anterior thoracic nerve, the costo-coracoid membrane, the cephalic vein, the acromio-thoracic vessels, the axillary lymphatic trunk, and the clavicular head of the pectoralis major; to the inner side and overlapping it when the arm is at the side of the body is the axillary vein; when the arm is abducted to a right angle with the body, the vein lies entirely to the inner side of the artery; to the outer side is the brachial plexus; behind is the first intercostal muscle, the first digitation of the serratus magnus, and the posterior thoracic nerve. It is important to remember the relation between the vein and artery when ligating the first portion of the latter. Its ligation may be beset with difficulties additional to its depth and its varying relations to its companion vein. The causes of these are the occasional entrance of the cephalic into the subclavian vein, thereby crossing the artery at a higher point, the presence of the enveloping plexus, formed by the external and internal anterior thoracic nerves, the

PLATE XXII.


Branch of
Acromio-thoracic a.
Suprascapular a.
Posterior scapular a.
Branch of
posterior circumflex a.
Subscapular a.
Suprascapular a.
Dorsalis scapulae a.

from the acromio-thoracic. It runs along the upper border of the pectoralis minor to supply both pectoral muscles, the serratus magnus, and the contents of the adjacent intercostal spaces. It anastomoses with the intercostal arteries.

The *acromio-thoracic artery* is a short trunk, or axis, springing from the axillary artery just above the upper margin of the pectoralis minor. It gives off three divergent branches—the thoracic, the acromial, and the descending or humeral—and a small twig (clavicular branch) to the subclavius muscle. The *thoracic branches* (two or three) go to the pectoral and serratus magnus muscles, and anastomose with the intercostal arteries and the intercostal branches of the internal mammary. The *acromial branches* pass outward over the coracoid process and under the deltoid to the top of the acromion, supplying the tissues of this region. They anastomose with the supra-scapular and anterior and posterior circumflex arteries, and form the acromial rete. The *descending* or *humeral branch* passes down the delto-pectoral sulcus in relation with the cephalic vein to supply the deltoid and pectoralis major muscles. It anastomoses with the anterior and posterior circumflex arteries. The *venæ comites of these branches* usually empty into the cephalic, but sometimes into the axillary vein.

THE SECOND PORTION.—In front of this portion are the pectoralis major and minor muscles; to the inner side are the inner cord of the axillary plexus and also the axillary vein, the latter lying a little anterior to the artery, but separated from it by the nerve cord; to the outer side is the outer cord of the plexus; behind is the posterior cord of the plexus and the subscapular muscle, from which both the artery and the nerve cord are separated by a quantity of areolar and fatty tissue. Its *branches* are the alar thoracic and the long thoracic.

The *alar thoracic artery* is a small branch distributed to the glands and the areolar tissue of the axilla. As a separate branch it is very often absent, in which event its place is taken by branches of one of the other thoracic arteries.

The *inferior* or *long thoracic* (deep external mammary) *artery* runs downward and inward along the lower border of the pectoralis minor to the side of the chest. It supplies the pectoral and serratus magnus muscles and the mammary gland, and anastomoses with the superior thoracic, intercostal, and internal mammary arteries.

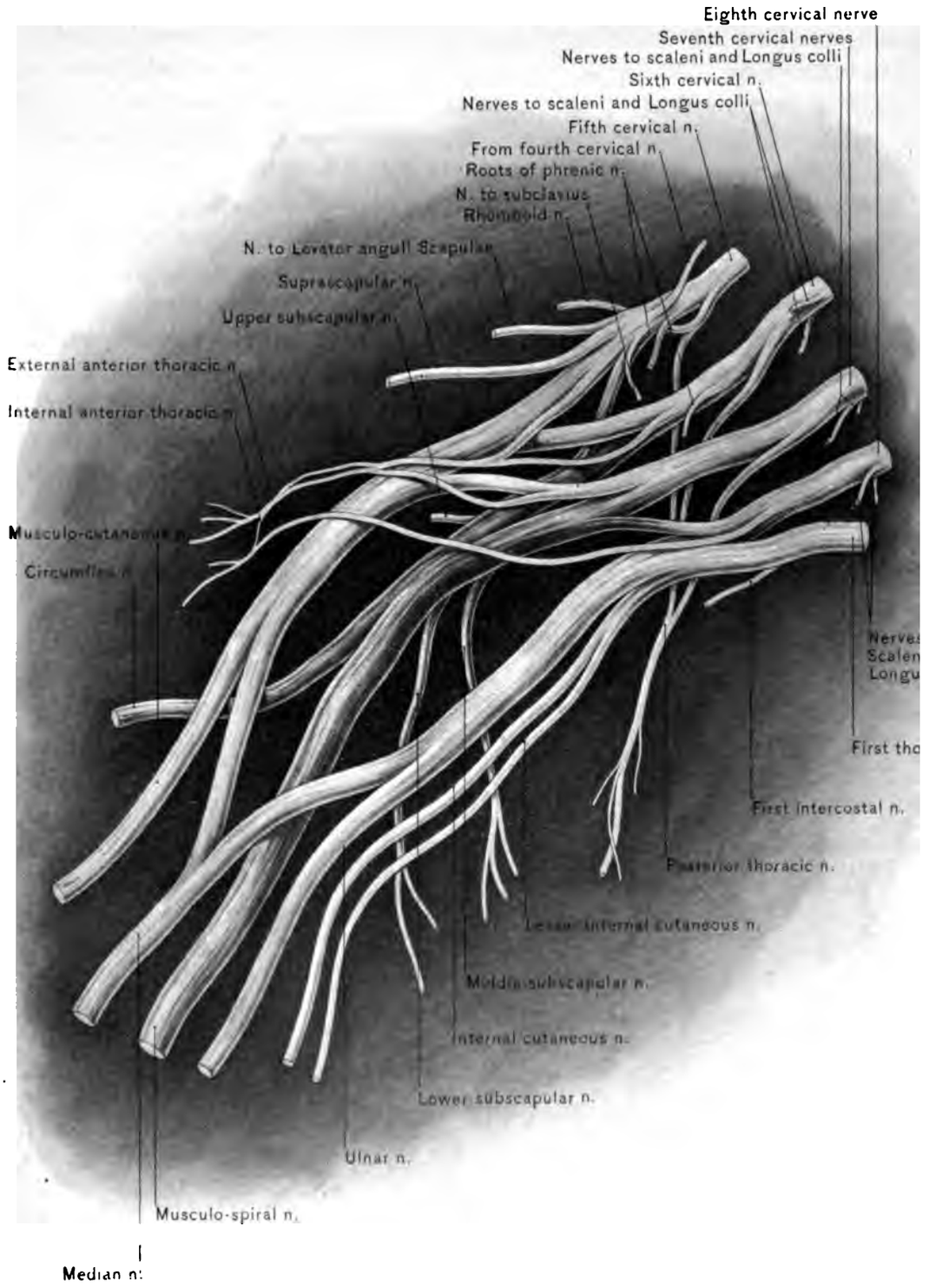
THE THIRD PORTION.—In front of the upper part of this portion are the superficial and deep fascia and the pectoralis major, while the lower part is only covered by skin, superficial and deep fascia. In front of this part of the artery are the inner head of the median nerve and the internal cutaneous nerve; to the inner side are the ulnar nerve, the axillary vein, and the lesser internal cutaneous nerve, the latter being separated from the artery by the vein; to the

muscle; while behind it are the musculo-spiral and circumflex nerves, the subscapularis muscle, and the tendons of the latissimus dorsi and teres major. Its *branches* are the subscapular, anterior circumflex, and posterior circumflex.

The *subscapular artery*, the largest branch of the axillary, arises opposite the outer or axillary border of the subscapular muscle. It runs inward and downward along this border to the inferior angle of the scapula, where it anastomoses with the posterior scapular, the larger of the two terminal branches of the transversalis colli. It also anastomoses with the long thoracic and the intercostal arteries. It is accompanied in the lower portion of its course by the long subscapular nerve. In its course it gives branches to the subscapularis, serratus magnus, latissimus dorsi, and teres major muscles, and to the glands and areolar tissue of the axilla. A short distance below its origin it gives off a large branch, the *dorsalis scapulæ*, which winds around the axillary border of the scapula between the subscapularis and teres minor, passing through the triangular subdivision of that general triangular space, situated at the axillary border of the scapula, to the dorsum of this bone, where it anastomoses with the supra-scapular and posterior scapular arteries. The space through which it passes is bounded by the subscapularis and teres minor, the teres major, and the long head of the triceps. A small branch is given off from the dorsalis scapulæ which enters the subscapular fossa beneath the subscapular muscle. The terminal part of the dorsalis scapulæ will be seen when dissecting the infra-spinous region of the scapula. A line drawn along the axillary border of the scapula to its inferior angle will indicate the course of the subscapular artery.

The **subscapular triangle,** the general triangular space already mentioned, is bounded above by the subscapular and teres minor muscles, below by the teres major, and on the outer side by the surgical neck of the humerus. This space is subdivided, by the long head of the triceps, into the triangular space proper, through which pass the dorsalis scapulæ vessels, and the quadrangular space, through which pass, as will be seen later, the posterior circumflex vessels and the

PLATE X


Eighth cervical nerve
Seventh cervical nerves
Nerves to scaleni and Longus colli
Sixth cervical n.
Nerves to scaleni and Longus colli
Fifth cervical n.
From fourth cervical n.
Roots of phrenic n.
N. to subclavius
Rhomboid n.
N. to Levator anguli Scapulæ
Suprascapular n.
Upper subscapular n.
External anterior thoracic n.
Internal anterior thoracic n.
Musculo-cutaneous n.
Circumflex n.
Nerves
Scalen
Longu
First tho
First intercostal n.
Posterior thoracic n.
Lesser internal cutaneous n.
Middle subscapular n.
Internal cutaneous n.
Lower subscapular n.
Ulnar n.
Musculo-spiral n.
Median n.

brachial, or superior profunda, or it may arise from the axillary as a common trunk with the subscapular.

The *anterior circumflex artery* arises from the outer aspect of the axillary, runs outward over the tendon of the latissimus dorsi and beneath the coracobrachialis and the short head of the biceps, and over the surgical neck of the humerus to the under surface of the deltoid, which it supplies. In excision of the shoulder-joint this artery is often difficult to ligate, as it lies close to the bone. A small branch, the *bicipital,* is given off from the anterior circumflex where it crosses the bicipital groove. This branch passes up the groove with the long tendon of the biceps and supplies the shoulder-joint and the head of the humerus. The anterior circumflex anastomoses with the posterior circumflex and the acromio-thoracic.

The **axillary or brachial plexus of nerves** in the neck consists of three trunks—an upper, a middle, and a lower; in the axilla, of three cords—an outer, an inner, and a posterior. The plexus is formed by the anterior divisions of the lower four cervical nerves and first dorsal nerve. The three trunks, seen in the deep dissection of the side of the neck, are formed as follows: The anterior primary divisions of the fifth and sixth cervical nerves form the upper trunk, the anterior primary divisions of the eighth cervical and first dorsal nerve form the lower trunk, and the anterior primary division of the seventh cervical forms the middle trunk. These trunks lie in relation with the second and third portions of the subclavian artery. The upper and middle trunks lie above the artery, while the lower is partly behind it.

These three trunks enter the axilla by way of its apex, lying above and to the outer (acromial) side of the first portion of the axillary artery. Each trunk divides into an anterior and a posterior branch. The anterior branches form the outer and inner cords of the plexus, while the posterior branches form the posterior cord. The anterior branches of the upper and middle trunks unite to form the outer cord, which lies on the outer side of the second portion of the axillary artery; the anterior branch of the lower trunk constitutes the inner cord of the plexus, which lies on the inner side of the artery; the posterior branches of all three trunks unite to form the posterior cord of the plexus, which lies behind the second portion of the axillary artery. Where, as occasionally happens, the posterior cord is formed simply by the union of the posterior branches of the upper and middle trunks, the posterior branch of the lower trunk, small in comparison with the others, unites with the musculo-spiral branch of the posterior cord.

Pressure upon the brachial plexus may be produced by an axillary tumor,

The pressure causes tingling, numbness, and pain in the upper extremity, and sometimes paralysis of some of the muscles of this part of the body.

The *branches* given off from the axillary plexus below the clavicle are the external and internal anterior thoracic, the three subscapular, the circumflex, the musculo-cutaneous or external cutaneous, the median, the ulnar, the internal cutaneous, the lesser internal cutaneous, and the musculo-spiral. Of these branches the external anterior thoracic, the outer head of the median, and the musculo-cutaneous arise from the outer cord; the subscapular, the circumflex, and the musculo-spiral from the posterior cord; and the inner head of the median, the ulnar, the internal cutaneous, the lesser internal cutaneous, and the internal anterior thoracic from the inner cord.

The **external or superficial anterior thoracic nerve** is derived from the beginning of the outer cord, just below the clavicle, passes inward across the axillary vessels, and pierces the costo-coracoid membrane to enter the under surface of the pectoralis major to supply it. It communicates with the internal anterior thoracic nerve.

The **internal or deeper anterior thoracic nerve,** smaller than the external, is derived from the inner cord, just below the clavicle, and passes forward between the axillary artery and vein, sometimes piercing the sheath of the latter. It enters the pectoralis minor, to which it gives branches, and then pierces it to enter the pectoralis major. It gives off a branch which forms, with a branch from the external anterior thoracic nerve, a loop around the inner side of the axillary artery, from which loop pass other branches to enter the pectoralis major.

The **three subscapular nerves**—the upper, the middle, and the lower—arise from the posterior cord. The upper or short subscapular supplies the upper part of the subscapular muscle; the middle or long subscapular accompanies the subscapular artery and supplies the latissimus dorsi muscle; the lower subscapular

minor, after which it passes under the deltoid and around the lower part of its posterior border to supply the skin over the long head of the triceps and the lower two-thirds of the posterior part of the deltoid. A *bicipital branch* arises from the end of the circumflex nerve and passes up the bicipital groove to supply the tendon of the long head of the biceps, the upper end of the humerus, and the shoulder-joint.

The **musculo-cutaneous or external cutaneous nerve** arises from the outer cord, opposite the lower border of the pectoralis minor. At its origin it lies close to the outer side of the axillary artery. It then passes outward and downward to the coraco-brachialis muscle, which it pierces and supplies, undergoing subdivision in its substance.

The **median nerve** is formed at the outer side, or in front of, the third portion of the axillary artery by the Y-shaped union of its two heads, the external and internal. The external head arises, with the musculo-cutaneous, from the outer cord; the internal head, with the ulnar, from the inner cord. The internal head crosses in front of the third portion of the axillary artery.

The **ulnar nerve** arises from the inner cord in common with the inner head of the median. It lies upon the inner side of the third portion of the axillary artery, between it and the axillary vein, and then passes down the inner side of the arm upon the inner surface of the triceps.

The **internal cutaneous nerve** arises from the inner cord and passes downward on the inner side of the axillary artery, between this vessel and the ulnar nerve.

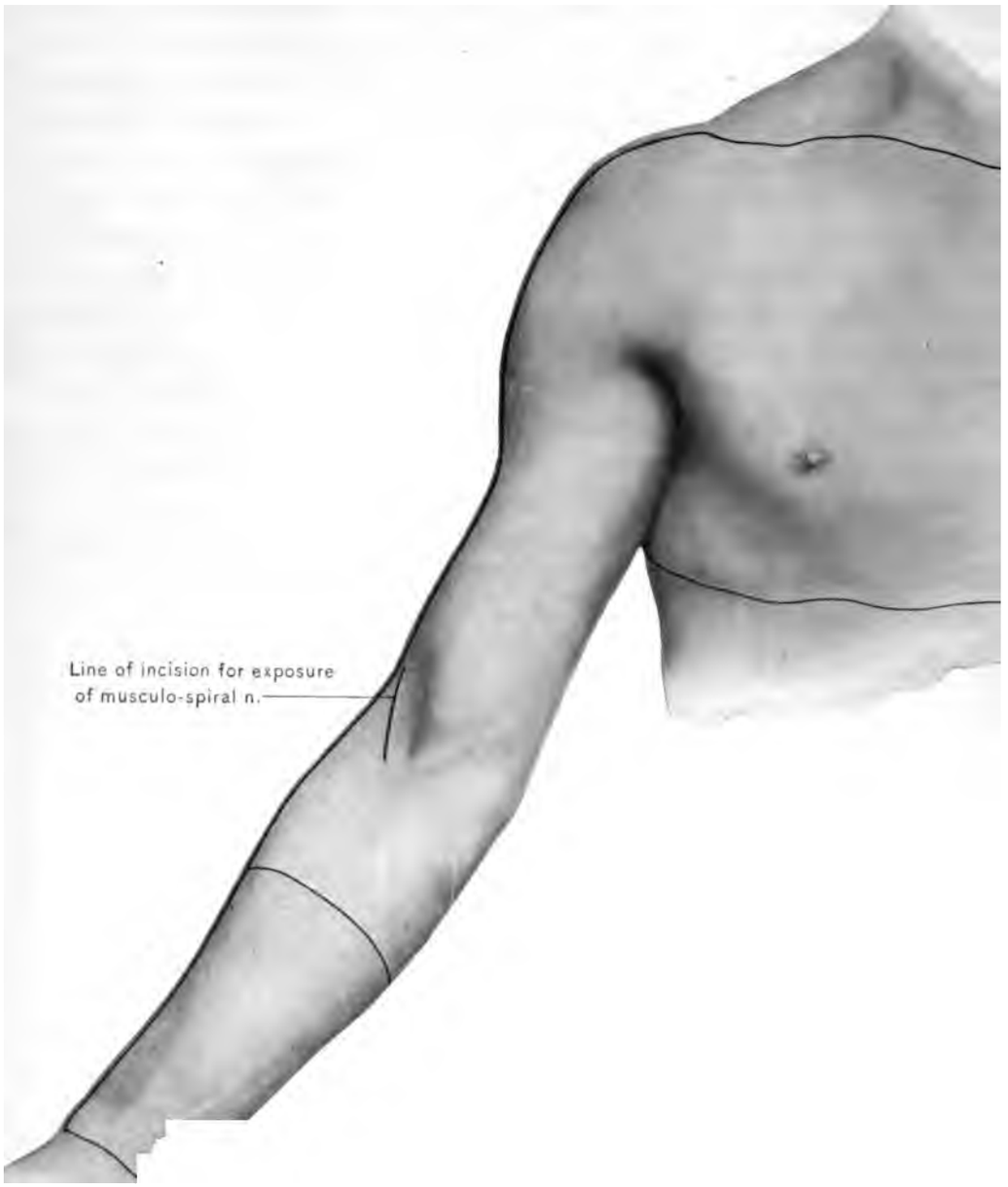
The **lesser internal cutaneous nerve** (nerve of Wrisberg), the smallest branch of the plexus, arises from the inner cord, passes behind the axillary vein and then along its inner side, where it is joined by the intercosto-humeral, which is the lateral cutaneous branch of the second intercostal nerve. The axillary vein

not uncommon to meet with two intercosto-humeral nerves, in which event the second is formed by the posterior branch of the lateral cutaneous branch of the third intercostal. The second intercosto-humeral nerve accompanies the first in its distribution. All of the lateral cutaneous branches of the intercostal nerves emerge from the intercostal spaces midway between the vertebræ and the sternum, and, with the exception of the second, divide into an anterior and a posterior branch. The first intercostal nerve does not, as a rule, give off a lateral cutaneous branch. Three intercosto-humeral nerves are not infrequently seen, the third one coming from the fourth intercostal nerve.

The **posterior or long thoracic nerve** (external respiratory nerve of Bell) is a branch of the brachial plexus given off above the clavicle, and lies along the inner wall of the axilla. It arises by three roots—the upper two from the fifth and sixth, and the lower from the seventh cervical nerve. The upper two roots pierce the scalenus medius muscle, while the lower root passes in front of it. Usually, the portion of the nerve formed by the union of the upper two roots and that formed by the lower root pass into the axilla separately behind the axillary plexus and vessels, where they join to form the common trunk which supplies the serratus magnus. It lies upon the outer surface of that muscle.

The **axillary lymphatic glands,** ten to twelve in number, most of which have been removed when clearing away the areolar and fatty tissue in exposing the contents of the arm-pit, consist of three chains—an anterior, a middle, and a posterior. The *anterior chain* lies on the serratus magnus, along the lower border of the pectoralis minor, and in relation with the long thoracic vessels. It receives most of the lymphatics of the mammary gland, particularly those from its outer portion, the lymphatics of the front of the chest, as well as the superficial lymphatics of the abdominal wall as low as the umbilicus. The glands comprising this chain are

PLATE XXIV.



may again be called to the importance of the relation that the middle chain holds to the axillary vein; for when these glands are diseased, they are apt to be adherent to this vessel and its sheath, under which circumstances the vein may be wounded and necessitate excision of a portion of the vessel. Enlarged axillary glands may press upon the axillary vein and thus produce edema of the arm. Edema of the arm following removal of the glands and areolar tissue of the axilla may be due to the loss of support afforded the axillary vein by these structures.

The areolar and adipose tissue which occupy the axilla are considerable in amount, and fill up the intervals between the other and more important structures. This tissue will appear more red in color and more granular and watery in character than adipose tissue elsewhere.

DISSECTION.—Upon the opposite side of the body the axilla should be dissected from below upward. Remove the skin and superficial fascia in the manner already described, when will be seen both the deep, or pectoral, and the axillary fascia.

The axillary fascia may be removed in one flap or divided longitudinally and reflected laterally, the dissection being carried far enough beyond the lower borders of the folds of the axilla to expose them thoroughly. In removing the axillary fascia care should be taken to disturb as little as possible the areolar tissue of this space, which is closely connected to the upper surface of the fascia. The areolar tissue is now to be removed, exposing, first, the intercosto-humeral nerve. The other structures seen in this dissection and along the outer wall are the axillary vein and artery, the middle chain of lymphatic glands, and the axillary plexus of nerves; along the posterior wall, the long subscapular nerve, accompanying the subscapular artery and vein, the lower and short subscapular nerves, and the posterior chain of lymphatic glands; along the inner wall, the long thoracic nerve; and along the anterior wall, the long thoracic artery and vein and the anterior chain of lymphatic glands.

To open a deeply-seated axillary abscess great care should be exercised. The skin and fascia should be incised, after which a grooved director is pushed forward until the outflow of pus along the groove denotes the finding of the cavity. A dressing forceps is to be introduced and forcibly withdrawn after having been

THE FRONT OF THE ARM.

DISSECTION.—Continue the incision already made upon the outer side of the arm to a point on the outer side of the forearm, about three inches below the external condyle. From the lower end of this incision make another transversely across the front of the forearm. Reflect the skin inward as one large flap, when the superficial fascia, with its ramifying nerves and vessels, will be exposed.

The Superficial Fascia.—This fascia is composed of two layers—a superficial, consisting mainly of adipose tissue; and a deep layer, fibrous in structure and in direct contact with the deep fascia. Between the two layers are the superficial nerves, vessels, and lymphatics. In the fascia upon the outer side of the arm are found the cutaneous branches of the circumflex nerve near the deltoid insertion, and below these the external cutaneous branches of the musculo-spiral nerve, while immediately above the elbow the musculo-cutaneous nerve becomes subcutaneous on the outer side of the tendon of the biceps. In addition to these nerves, the cephalic vein is seen on the outer side of the arm. In the fascia on the inner side of the arm are found the intercosto-humeral nerve, the internal cutaneous branch of the musculo-spiral nerve, the internal cutaneous and lesser internal cutaneous nerves, and the basilic vein. In order to trace these nerves and vessels the superficial fascia is to be removed as the skin was, being careful not to sever the structures which enter it from beneath. As each nerve or vessel is exposed, trace it through the superficial fascia.

The **cutaneous branches** of the superior division of the circumflex nerve pierce the deltoid near its insertion and are distributed to the skin over the lower

PLATE XX

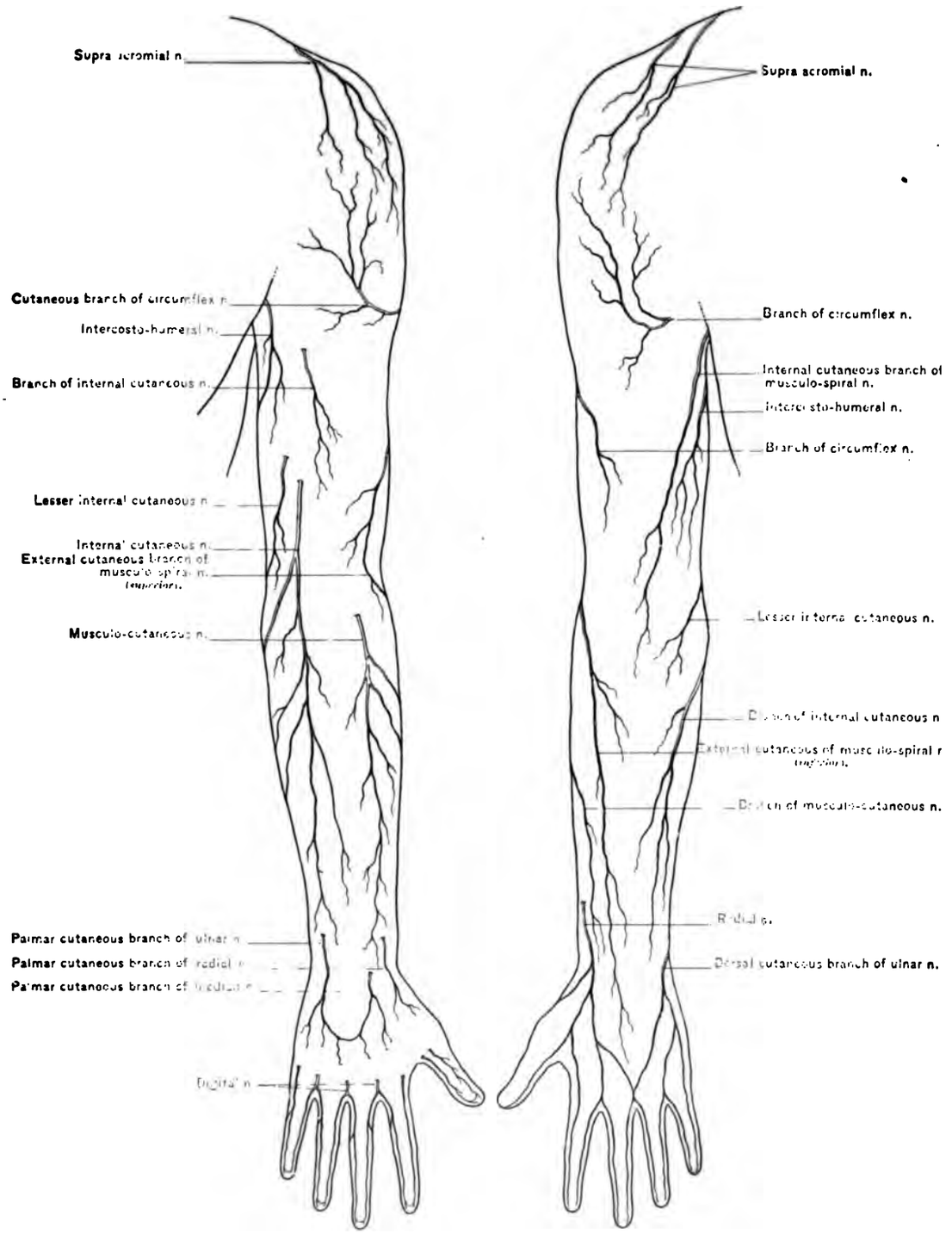

Supra acromial n.
Cutaneous branch of circumflex n.
Intercosto-humeral n.
Branch of internal cutaneous n.
Lesser internal cutaneous n.
Internal cutaneous n.
External cutaneous branch of musculo-spiral n.
Musculo-cutaneous n.
Palmar cutaneous branch of ulnar n.
Palmar cutaneous branch of radial n.
Palmar cutaneous branch of median n.
Digital n.
Supra acromial n.
Branch of circumflex n.
Internal cutaneous branch of musculo-spiral n.
Intercosto-humeral n.
Branch of circumflex n.
Lesser internal cutaneous n.
Dorsal cutaneous branch of ulnar n.

PLATE XXVI.

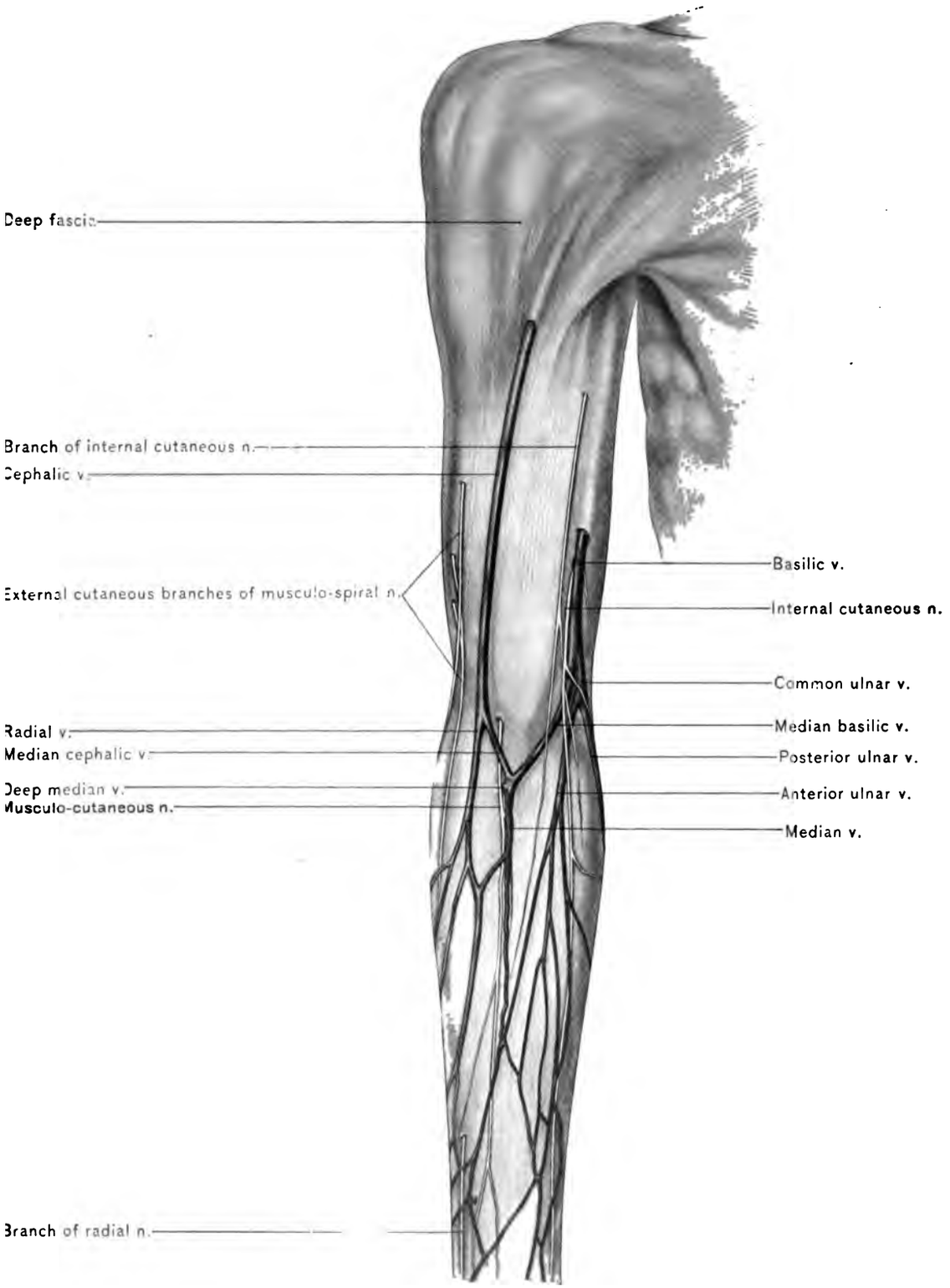
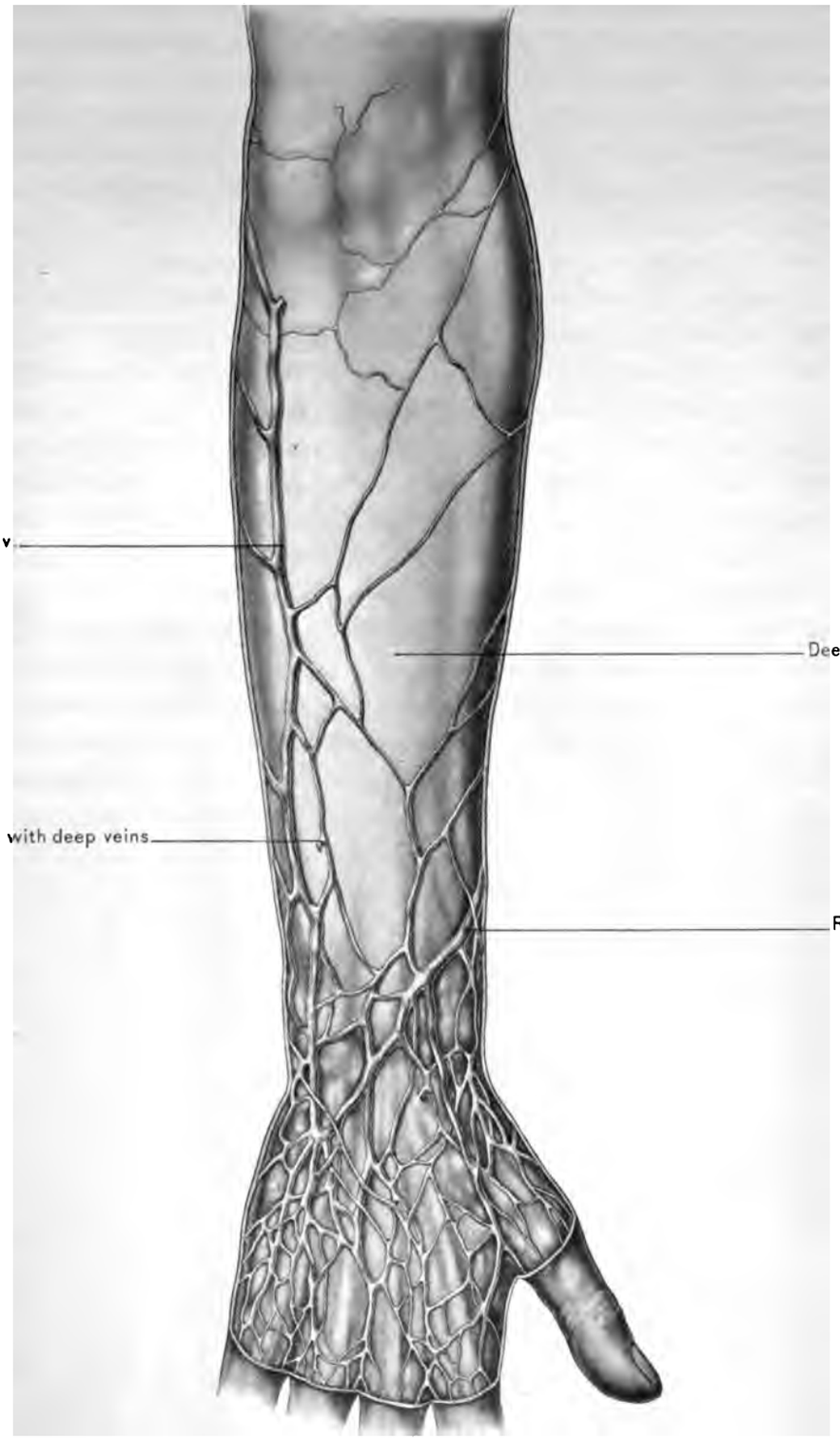

Deep fascia
Branch of internal cutaneous n.
Cephalic v.
External cutaneous branches of musculo-spiral n.
Radial v.
Median cephalic v.
Deep median v.
Musculo-cutaneous n.
Branch of radial n.
Basilic v.
Internal cutaneous n.
Common ulnar v.
Median basilic v.
Posterior ulnar v.
Anterior ulnar v.
Median v.

PLATE XX


Posterior ulnar v.
Deep fascia
Communication with deep veins
Radial v.

off a cutaneous branch which arises high up, pierces the deep fascia at the lower border of the posterior fold of the axilla, and goes to the skin of the inner side and front of the arm. The anterior branch passes downward over the elbow, either in front of or behind the median basilic vein, to supply the skin of the front and inner side of the forearm. At the wrist it communicates with a cutaneous branch of the ulnar nerve. The posterior branch communicates with the lesser internal cutaneous nerve above the elbow, and then passes downward behind the internal condyle to supply the skin over the posterior and inner aspect of the forearm, and communicates with the dorsal branch of the ulnar nerve above the wrist-joint.

The **lesser internal cutaneous nerve** (nerve of Wrisberg) pierces the deep fascia at the middle of the arm, supplies the skin over the lower one-third of the back of the arm as well as that over the internal condyle and olecranon, and communciates with the posterior branch of the internal cutaneous nerve.

The **internal cutaneous branch** of the musculo-spiral nerve is small. It arises in the axilla, and pierces the deep fascia in the upper part of the arm to supply the skin of the inner side and back of the arm almost as far as the olecranon.

Superficial Arteries.—The arteries which ramify in the superficial fascia of the arm are derived from above downward—from the acromio-thoracic, the anterior and posterior circumflex, the superior and inferior profunda, the muscular, and the anastomotica magna.

Superficial Veins.—The veins found in the superficial fascia of the arm are of special interest because of their symmetric arrangement and surgical importance, those in front of the elbow being especially important in venesection or blood-letting. Like veins generally, they are subject to frequent variations; but nevertheless adhere, as a rule, to the following plan:

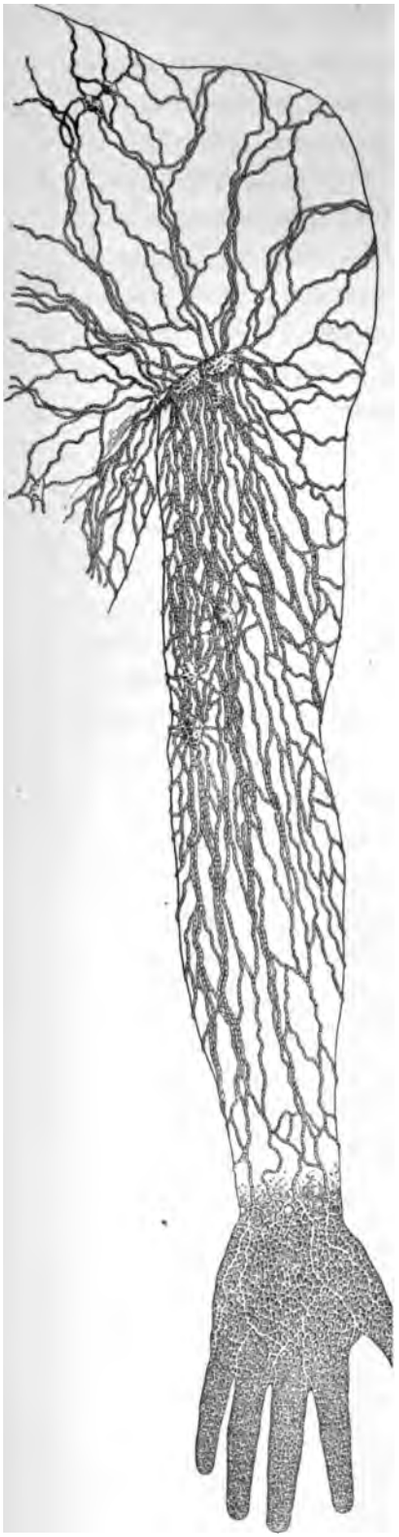
The **cephalic vein** is formed by the junction of the radial and median cephalic veins in the groove between the supinator longus and the lower, tapering end of the biceps muscle. It passes upward over the outer edge of the biceps muscle; and, after piercing the deep fascia, dips into the delto-pectoral sulcus, where it is accompanied by the descending branch of the acromio-thoracic artery. Just below the middle of the clavicle it pierces the costo-coracoid membrane and empties into the third portion of the axillary vein.

The **median cephalic vein** is a short, venous trunk, from one and one-half to two and one-half inches in length, connecting the lower end of the cephalic vein with the upper end of the median vein of the forearm, from which it arises, in common with the median basilic, about opposite the lower end of the tendon of

median cephalic, extends inward in front of the bicipital fascia, observing a more nearly transverse course than the latter vein. It joins the common ulnar vein shortly after the formation of the latter by the junction of the anterior and posterior ulnar veins. It generally follows the course of the sulcus between the inner edge of the lower end of the biceps and the outer edge of the pronator radii teres. It crosses the brachial artery, from which it is separated by the bicipital fascia. Branches of the internal cutaneous nerve pass in front of and behind it. This is the vein most commonly selected for intra-venous saline infusion.

In venesection, or blood-letting, this is the vessel usually selected for that purpose, because it is the larger of the two, and therefore affords a freer flow of blood. From an anatomic standpoint, however, the median cephalic is the safer of the two vessels from which to bleed, on account of the more intimate relation of the median basilic vein to the brachial artery. When the practice of bleeding was so common, the thumb lancet was used in making the section of the vein. As the blade of this instrument was at a right angle to the handle and was driven by a spring, it can be readily understood why the artery was endangered if the lancet was not held at the proper height. To obviate the risk of injuring the brachial artery, the vein should be exposed by dissection and cut obliquely in preference to transversely to preclude the danger of completely dividing the vessel. The opening in the skin should be larger than that in the vein, so that blood will not escape into the cellular tissue and form a thrombus. If the blood does not flow freely when the vein is opened, the patient should move his fingers while grasping something in his hand; this favors compression of the deep veins and causes the blood to flow into the superficial veins through the mediana profunda and the remaining veins that connect the superficial and deep veins.

The **basilic vein,** which is much larger than the cephalic, is formed by the junction of the common ulnar and median basilic veins, and passes upward in



junction of the lymphatics from the outer and inner side of the front of the forearm, pass along the inner side of the arm with the basilic vein to enter the axillary glands. A few of those on the outer side of the forearm pass up the outer side of the arm with the cephalic vein and, crossing the biceps in its upper part, join the axillary glands, though one or two lymphatic vessels usually continue with the cephalic vein through the delto-pectoral sulcus to enter the subclavian glands. The deep lymphatics follow the course of the arteries. One or more lymph-glands are occasionally found in the delto-pectoral sulcus.

DISSECTION.—Reflect the superficial fascia in the same manner in which the skin was reflected. In removing this fascia the superficial veins and nerves are to be traced. It is more convenient to follow these structures through the under surface of the fascia.

Deep fascia.—The removal of the superficial fascia exposes the deep fascia, which is fibrous in structure. It is continuous with its adjacent counterparts of the shoulder, back, chest, and forearm. It is attached above to the anterior edge of the clavicle and to the outer and inferior edges of the acromion process and spine of the scapula. Passing downward, it envelops the muscles and other deep structures of the arm and is attached, below the tendon of the triceps muscle, to the bony prominences of the elbow-joint, the olecranon and condyles, whence it continues downward as the general investiture of the forearm. In addition to enveloping the muscles by means of processes constituting sheaths, it forms partitions between them. Two of these, one on either side of the arm, are known as the internal and external intermuscular septa. It varies in thickness, being thickest over the triceps and the condyles of the humerus, thinnest in front of the biceps, and intermediate in thickness upon the inner side of the arm, where it serves to cover and protect the main vessels and nerves. Internally, it is reinforced by accessory fibers from the tendons of the pectoralis major and latissimus dorsi, and externally by fibers from the tendon of the deltoid.

The **intermuscular septa.**—The *internal* intermuscular septum is attached to the internal condyloid ridge, and extends from the insertion of the coraco-brachialis to the internal condyle of the humerus. It blends with the tendon of the coraco-brachialis, and gives attachment to the triceps behind and the brachialis anticus and pronator radii teres in front. In the middle of the arm it is perforated by the ulnar nerve and inferior profunda artery, and below

forated below the middle of the arm by the musculo-spiral nerve and the superior profunda artery.

These intermuscular septa, with the bone, divide the lower half of the arm into two osteo-fascial compartments—an anterior and a posterior. In the anterior compartment are found the biceps, the brachialis anticus, and the origins of the supinator longus and extensor carpi radialis longior, the brachial vessels, the basilic vein, the anastomotica magna, the inferior profunda and the termination of the superior profunda, the radial recurrent and anterior ulnar recurrent arteries, the median, ulnar, internal cutaneous, and musculo-cutaneous nerves, and the lower part of the musculo-spiral nerve. In the posterior compartment are the triceps muscle, the musculo-spiral nerve, the superior profunda artery, the ulnar nerve, the inferior profunda artery, and the anastomotica magna artery.

Dissection.—Divide the deep fascia in the median line of the front of the arm and reflect it laterally, exposing to view those structures which lie in the anterior part of the arm. In reflecting the fascia from the inner side of the arm it is best to sever the internal intermuscular septum, taking care, however, not to injure the structures that pierce it. This will expose, in front, the biceps; on the inner side, the coraco-brachialis, the brachialis anticus, and the triceps; on the outer side, the deltoid, brachialis anticus, and the origins of the supinator longus and extensor carpi radialis longior. The sulcus upon the inner side of the arm, between the biceps in front and the triceps and brachialis anticus behind, is occupied by the principal vessels and nerves. Before proceeding further with the dissection the student should carefully examine the relation of the brachial vessels to the coraco-brachialis and biceps muscles, and the median nerve which accompanies the vessels, as the relations of these structures are somewhat altered by cleaning.

The **brachial artery,** the continuation of the axillary, begins opposite the lower border of the tendon of the teres major. It passes down the inner side of the arm, overlapped for fully two-thirds of its course by the inner border of the coraco-brachialis and biceps muscles. It then curves inward in front of the elbow-joint, along the inner border of the tendon of the biceps, opposite the insertion of which, one-half to one inch below the elbow-joint, it divides into the radial and

PLATE XXIX.

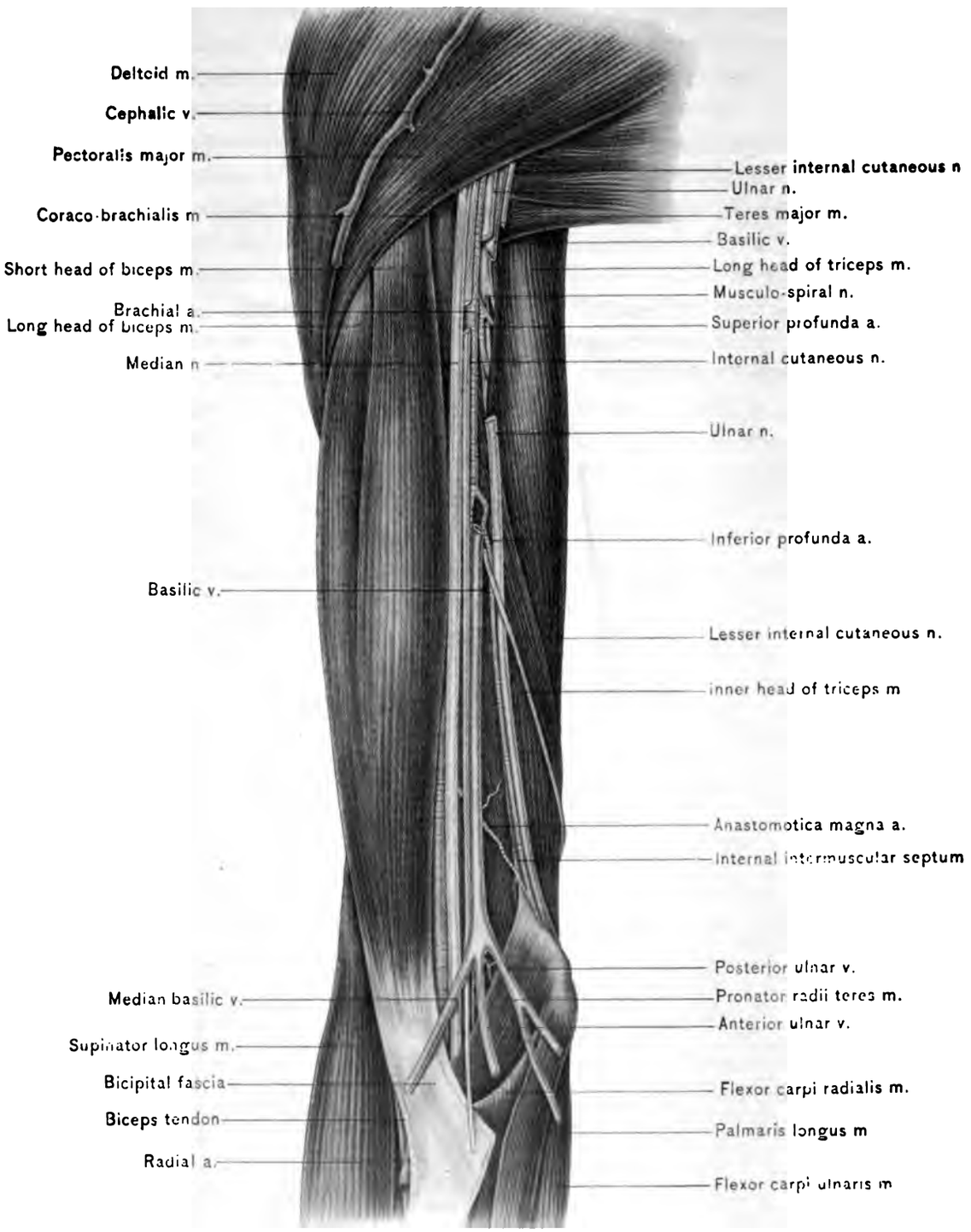
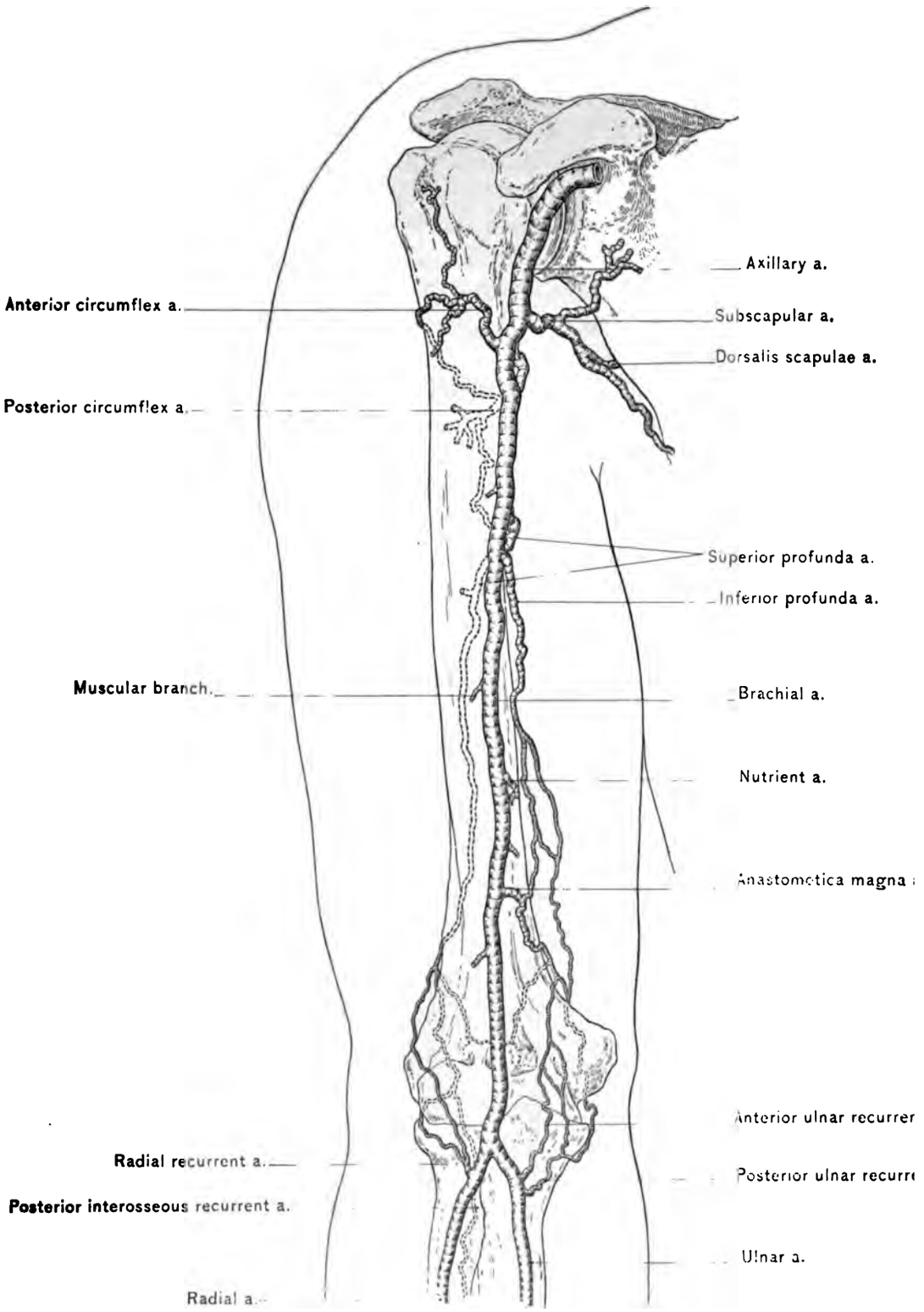

Deltoid m.
Cephalic v.
Pectoralis major m.
Coraco-brachialis m
Short head of biceps m.
Brachial a.
Long head of biceps m.
Median n
Basilic v.
Median basilic v.
Supinator longus m.
Bicipital fascia
Biceps tendon
Radial a.
Lesser internal cutaneous n
Ulnar n.
Teres major m.
Basilic v.
Long head of triceps m.
Musculo-spiral n.
Superior profunda a.
Internal cutaneous n.
Ulnar n.
Inferior profunda a.
Lesser internal cutaneous n.
Inner head of triceps m
Anastomotica magna a.
Internal intermuscular septum
Posterior ulnar v.
Pronator radii teres m.
Anterior ulnar v.
Flexor carpi radialis m.
Palmaris longus m
Flexor carpi ulnaris m

PLATE X


Axillary a.
Anterior circumflex a.
Subscapular a.
Dorsalis scapulae a.
Posterior circumflex a.
Superior profunda a.
Inferior profunda a.
Muscular branch.
Brachial a.
Nutrient a.
Anastomotica magna
Anterior ulnar recurrer
Radial recurrent a.
Posterior ulnar recurre
Posterior interosseous recurrent a.
Ulnar a.
Radial a.

When the biceps arises by three heads, the artery, at its upper portion, lies beneath the innermost head. The median nerve, for about one inch, also lies on its outer side in the groove between the artery and the coraco-brachialis. In front of the artery are the skin and fasciæ, the inner borders of the coraco-brachialis and biceps in the upper two-thirds of its course, the median nerve in the middle third, and the bicipital fascia and median basilic vein below; on the inner side are the ulnar nerve in the upper half of its course, the internal cutaneous nerve and basilic vein in the upper two-thirds of its course, and the median nerve in the lower third; behind are the musculo-spiral nerve and superior profunda artery, the long and inner heads of the triceps in the upper part of the arm, the insertions of the coraco-brachialis in the middle, and the brachialis anticus in the lower part of the arm. Throughout its course it is flanked by two closely adjacent accompanying veins (venæ comites), connected with each other by occasional transverse veins.

The artery is comparatively superficial throughout its entire extent, being covered by skin and superficial and deep fascia, except in the middle of its course, where the median nerve lies in front, and at its lower end, where the bicipital fascia and median basilic vein are in front of it. It is most readily compressed in the middle of the arm, where it rests upon the insertion of the coraco-brachialis. The pressure should be directed outward and backward. This is the most suitable point for compressing the artery with the pad of the tourniquet in amputation of the forearm or lower arm.

The *branches of the brachial artery* are the superior and the inferior profunda, nutrient, anastomotica magna, muscular, and occasionally vasa aberrantia.

The **superior profunda artery,** the largest branch, arises from the inner and back part of the upper end of the brachial, and, turning backward, it enters the musculo-spiral groove with the musculo-spiral nerve. In the groove it passes behind the humerus, between the inner and outer heads of the triceps, to the outer side of the arm, pierces the external intermuscular septum, and continues downward between the brachialis anticus and supinator longus muscles to the elbow, where it anastomoses with the radial recurrent. In its course it sends branches to supply the deltoid, coraco-brachialis, and triceps muscles, and a branch to anastomose with the circumflex arteries. It gives off a large *posterior*

of the inner head of the triceps. It pierces the internal intermuscular septum and accompanies the ulnar nerve between the internal condyle and olecranon, where it anastomoses with the posterior ulnar recurrent and the anastomotica magna. It also sends downward in front of the internal condyle a small branch which anastomoses with the anterior ulnar recurrent and the anastomotica magna. At times it arises with the superior profunda by a common trunk.

The **nutrient artery** leaves the brachial in the middle of the arm, and, passing downward, pierces the tendon of the coraco-brachialis to enter the nutrient canal of the humerus below the insertion of that muscle. Sometimes it arises from the superior profunda. Entering the bone with it is a filament of the musculo-cutaneous nerve.

The **anastomotica magna artery** is given off a short distance above the elbow, whence it passes inward over the brachialis anticus muscle and pierces the internal intermuscular septum. It then winds around the humerus between the triceps and the bone, and anastomoses above the olecranon with the posterior articular branch of the superior profunda and the interosseous recurrent. While crossing the brachialis anticus it gives off an anastomotic branch which also pierces the internal intermuscular septum to join the posterior ulnar recurrent, between the olecranon and the internal condyle. Ascending and descending branches are also given off to join the inferior profunda above, and the anterior ulnar recurrent in front of the internal condyle.

Muscular branches arise from the outer side of the brachial artery and supply the coraco-brachialis, biceps, and brachialis anticus muscles.

Vasa aberrantia are long, narrow arteries which are occasionally found connecting the brachial or axillary artery with some of the main arteries of the forearm, usually the radial.

The vasa aberrantia, together with the liberal anastomosis around the elbow-joint, are very important, as they offer channels for collateral circulation of the

PLATE X

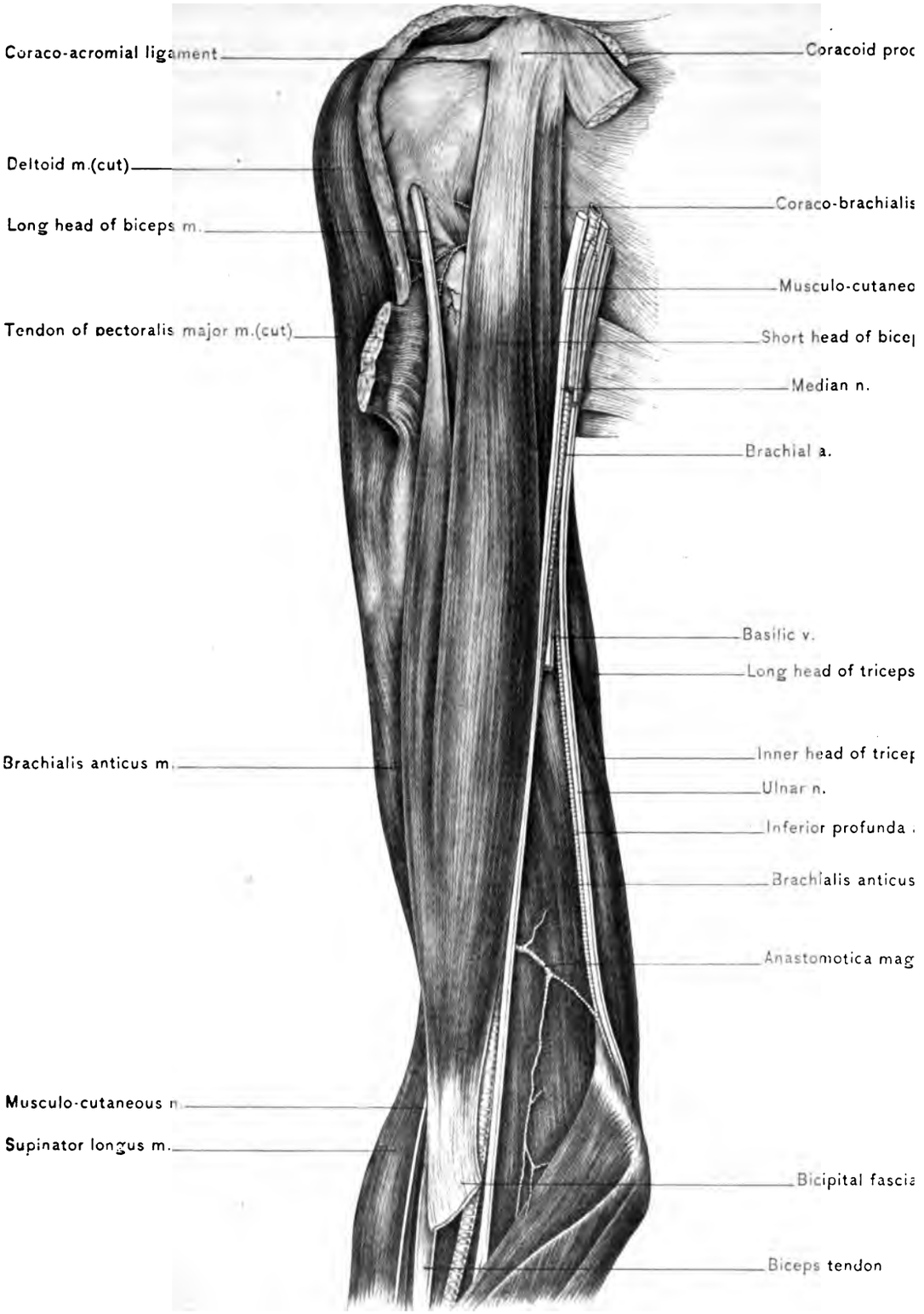
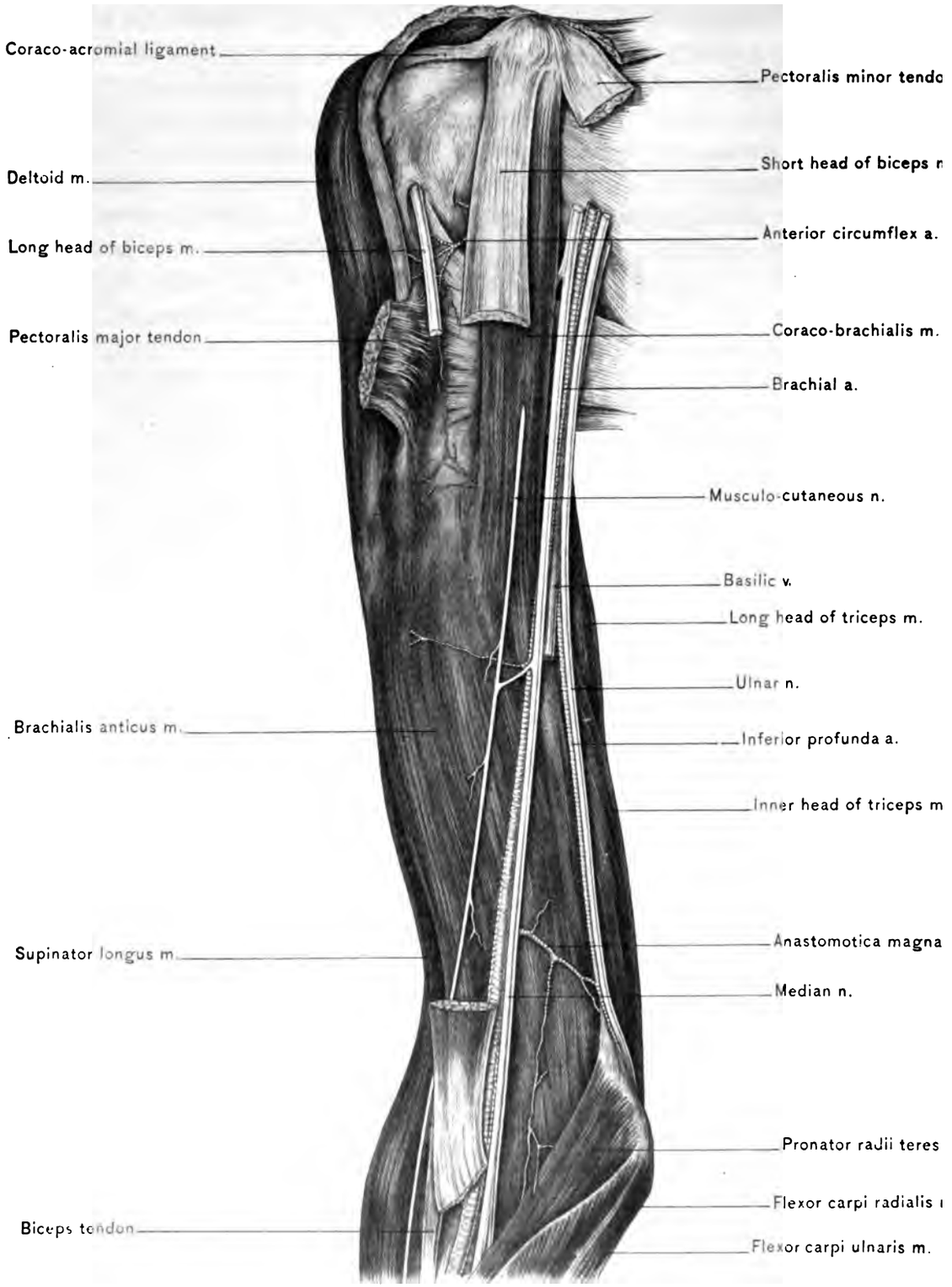

Coraco-acromial ligament
Deltoid m.(cut)
Long head of biceps m.
Tendon of pectoralis major m.(cut)
Brachialis anticus m.
Musculo-cutaneous n.
Supinator longus m.
Coracoid proc
Coraco-brachialis
Musculo-cutaneo
Short head of bicep
Median n.
Brachial a.
Basilic v.
Long head of triceps
Inner head of tricep
Ulnar n.
Inferior profunda a.
Brachialis anticus
Anastomotica mag
Bicipital fascia
Biceps tendon

PLATE XXXII.


Coraco-acromial ligament
Deltoid m.
Long head of biceps m.
Pectoralis major tendon
Brachialis anticus m.
Supinator longus m.
Biceps tendon
Pectoralis minor tendo
Short head of biceps r
Anterior circumflex a.
Coraco-brachialis m.
Brachial a.
Musculo-cutaneous n.
Basilic v.
Long head of triceps m.
Ulnar n.
Inferior profunda a.
Inner head of triceps m
Anastomotica magna
Median n.
Pronator radii teres
Flexor carpi radialis
Flexor carpi ulnaris m.

emerges from the capsule, where the latter unites with the humerus. It passes down the bicipital groove, in which it is retained by an aponeurosis derived from the tendon of the pectoralis major. Its synovial sheath covers it in the upper two inches of the groove. This head becomes muscular shortly after leaving the groove. The *short head* takes its origin from the tip of the coracoid process of the scapula by a flattened tendon in common with the coraco-brachialis, whence it passes downward and a little outward to join the long head opposite the middle of the humerus. The biceps ends below in a flattened tendon, which, after giving off an aponeurotic expansion (bicipital aponeurosis) from its inner side, becomes twisted upon itself, and is inserted into the posterior edge of the tuberosity of the radius. A synovial sac intervenes between the tendon and the anterior part of the tuberosity. The bicipital aponeurosis passes inward over the brachial artery and beneath the median basilic vein and blends with the deep fascia of the forearm. Interest attaches to the relation of the brachial artery to the bicipital aponeurosis and the median basilic vein, because, inexplicable as such an accident may seem, it has happened that the artery, as well as the vein, has been opened in venesection, an arterio-venous aneurysm resulting. The two bellies of this muscle are united by connective tissue almost as far as the tendon, near which their fibers interdigitate before attachment to the front of this structure. The biceps, in its upper part, rests upon the musculo-cutaneous nerve, which passes obliquely behind it, and against the humerus; in its lower half it lies upon the brachialis anticus. Its tendon occupies the triangular space in front of the elbow, the brachial artery being on its inner side. On the inner side of the muscle are the coraco-brachialis muscle, the brachial vessels, and the median nerve. Its upper end is covered by the tendon of the pectoralis major and the anterior edge of the deltoid. For the remainder of its course it is subcutaneous and readily discernible.

Occasionally, between the coraco-brachialis and brachialis anticus, there arises from the inner side of the humerus an accessory head, which, in its

The **coraco-brachialis muscle,** arising conjointly with the short head of the biceps, extends from the tip of the coracoid process to the middle of the inner side of the humerus, where it is inserted into a rough impression between the attachment of the inner head of the triceps and the brachialis anticus, and opposite the insertion of the deltoid. It is perforated obliquely, from within outward, by the musculo-cutaneous nerve, from which it derives its nerve supply. Above, it is hidden by the pectoralis major and deltoid; it then becomes superficial as far as its insertion, where it is crossed by the brachial vessels and median nerve. Behind, this muscle is in contact with the tendons of the subscapularis, teres major, and latissimus dorsi, and the short head of the triceps muscle, the humerus, and the anterior circumflex vessels. Internally, it is in relation with the pectoralis minor, the third part of the axillary artery, the brachial vessels, and the median and musculo-cutaneous nerves. Externally, it lies in contact with the short head of the biceps. It derives its nutriment chiefly from the brachial artery.

Action.—Its function is to draw the arm forward and inward.

The **brachialis anticus muscle** arises from the humerus by two fleshy digitations on either side of the insertion of the deltoid, and from the front and inner side of the shaft of the bone below this point, as well as from the external and internal intermuscular septa. It is a broad, flat muscle, which covers the lower half of the front of the humerus and the anterior ligament of the elbow-joint, to which it is closely attached. It ends in a short tendon, which is inserted into the front of the base of the coronoid process of the ulna, where it bears the same relation to the two digitations of the flexor profundus digitorum that the insertion of the deltoid does to it above. This muscle is covered by the deep fascia on the outer side and by the biceps, and is crossed by the brachial vessels, the median, the musculo-cutaneous, and musculo-spiral nerves. Externally, it is related with the musculo-spiral nerve, the superior profunda and radial recurrent arteries, the long radio-carpal extensor and long supinator muscles; while internally it is in contact with the triceps, ulnar nerve, and pronator radii teres.

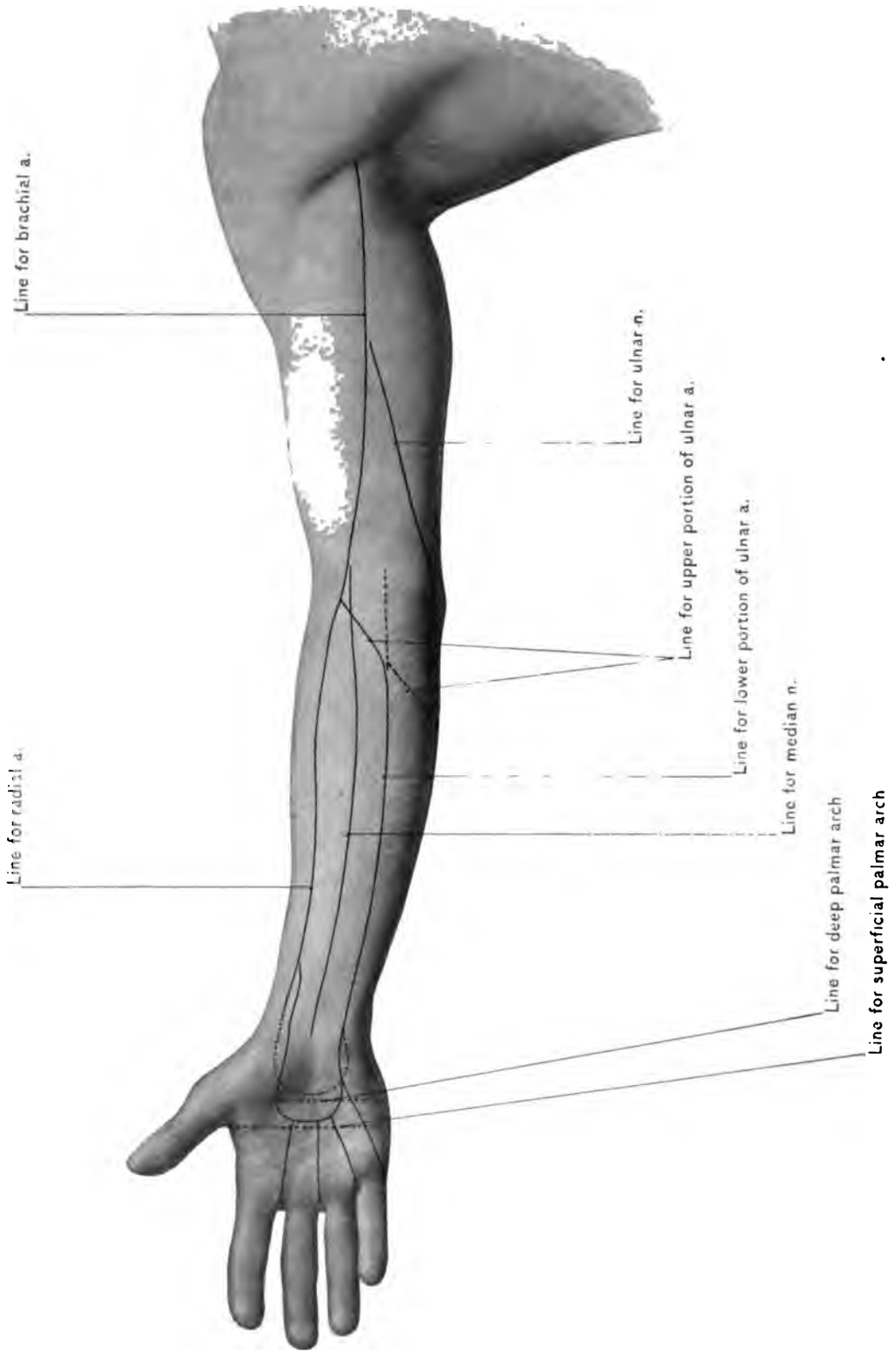
Blood Supply.—From the brachial artery.

Nerve Supply.—From the musculo-cutaneous and the musculo-spiral nerves.

Action.—To flex the forearm on the arm.

The **Nerves of the Arm** proceed from the axillary or brachial plexus. They

LATE XXXIII.


Line for brachial a.
Line for ulnar n.
Line for upper portion of ulnar a.
Line for lower portion of ulnar a.
Line for radial a.
Line for median n.
Line for deep palmar arch
Line for superficial palmar arch

musculo-spiral curve behind the humerus to the outer side of the arm; the musculo-cutaneous crosses the front of the arm to the outer side of the forearm. Of these, the circumflex is the only one which has ascending branches.

The **musculo-cutaneous nerve,** arising from the outer cord of the axillary or brachial plexus, opposite the lower margin of the pectoralis minor, at once enters the coraco-brachial muscle, through which it passes downward and outward, thence between the biceps and brachialis anticus to the outer side of the arm a little above the elbow, where it pierces the deep fascia. It supplies the coraco-brachialis, biceps, and brachialis anticus muscles, the humerus, and the elbow-joint. At the elbow it passes beneath the median cephalic vein and divides into an anterior and a posterior branch. The anterior branch communicates with the radial nerve and ends in the skin over the thenar eminence; the posterior branch supplies the skin as far as the wrist. Loss of the power of elbow flexion, associated with numbness or anesthesia of the outer side of the forearm, would indicate an affection of this nerve.

The **median nerve** is formed by two fasciculi, or nerve strands, one from the outer and the other from the inner cord of the axillary plexus; they unite like the arms of the letter Y and are known as the outer and the inner heads, the stem formed by their union being the median nerve. The two heads lie on opposite sides of the lower or third portion of the axillary artery and unite either in front of it or on its outer side. In its course along the inner side of the arm it hugs the brachial artery, being generally upon the outer side of this vessel in its upper part, then gradually moving inward to rest in front of it in the middle of the arm, and continuing inward so that it lies upon the inner side of this vessel in the lower third of the arm. At the lower end of the arm it is covered by the bicipital aponeurosis or fascia, and is crossed by the median basilic vein. It gives off muscular branches and the anterior interosseous nerve, and continues downward to the palm. In the middle of the arm the median nerve is occasionally found behind the brachial artery, instead of in front.

The **ulnar nerve** arises, in common with the inner head of the median nerve, from the inner cord of the axillary plexus. It passes downward along the inner side of the axillary and brachial arteries, diverging inward from the latter at the middle of the arm opposite the insertion of the coraco-brachialis muscle. It then crosses the inner head of the triceps and, in company with the inferior profunda artery, pierces the internal intermuscular septum to enter the groove between the olecranon and internal condyle. Special interest attaches to the position of the

and ring fingers, whence is derived the name "crazy bone" or "funny bone." The ulnar nerve holds so close a relation to the posterior surface of the internal condyle that, in fracture of the condyle, a fragment or callus may press upon the nerve and produce tingling or numbness of the ulnar side of the forearm and hand, little finger, and ulnar side of the ring finger, and spasm or paralysis of the muscles supplied by this nerve. These muscles are the flexor carpi ulnaris, ulnar side of the flexor profundus digitorum, palmaris brevis, muscles of the hypothenar eminence, interossei, two ulnar lumbricales, adductor pollicis, and inner head of the flexor brevis pollicis.

The **internal cutaneous nerve** arises from the inner cord of the axillary plexus, passes downward along the inner side of the axillary and brachial arteries, between the latter and the ulnar nerve, and divides a little below the middle of the arm into an anterior and a posterior branch. The anterior branch enters the forearm either in front of, or behind, the median basilic vein; the posterior branch descends along the inner side of the basilic vein to enter the forearm behind the internal condyle. Before it divides, it gives off a cutaneous branch, which pierces the deep fascia and supplies the skin of the anterior and inner side of the arm almost as far as the elbow.

The **lesser internal cutaneous nerve** (nerve of Wrisberg) arises from the inner cord of the axillary plexus above the origin of the internal cutaneous nerve, from which point it passes behind the axillary vein, and then on the inner side of the vein, where it communicates with the lateral cutaneous branch of the second intercostal nerve (the intercosto-humeral). It then passes downward to the middle of the arm, where it pierces the deep fascia, and is distributed to the skin over the lower part of the back of the arm, the inner condyle, and the olecranon.

The **circumflex nerve** arises, with the musculo-spiral, from the posterior cord of the axillary plexus. It descends in front of the subscapularis muscle behind the axillary artery, and turns backward at the lower margin of the muscle, giving off an articular branch which enters the shoulder-joint below the subscapularis. It divides into an upper and a lower branch. The upper branch, in company with the posterior circumflex vessels, curves behind the surgical neck of the humerus and under the deltoid to its anterior border, giving off filaments in its course to supply the muscle and the skin covering it. The lower branch sends to the teres

is the largest branch of the axillary plexus. It passes downward behind the axillary vessels and in front of the tendons of the latissimus dorsi and teres major. Accompanied by the superior profunda artery, it then passes downward and outward between the outer and inner heads of the triceps around the back of the humerus in the musculo-spiral groove to the outer side of the lower part of the arm, where it pierces the external intermuscular septum. Thence it continues downward between the brachialis anticus, internally, and the supinator longus, externally, to the front of the outer condyle, where it divides into the radial and posterior interosseous nerves. On the inner side of the arm it gives off *internal muscular branches* to the outer and inner heads of the triceps; in the musculo-spiral groove it sends branches to the outer head of the triceps and the anconeus; on the outer side of the arm it gives off external branches to the supinator longus, extensor carpi radialis longior, and brachialis anticus. A *small internal cutaneous branch* arises in the axilla, and passes to the skin of the inner side and back of the arm almost as far as the olecranon. A *superior external cutaneous branch* perforates the external head of the triceps close to the humerus, then pierces the deep fascia and accompanies the cephalic vein to the front of the elbow, supplying the skin of the lower half of the front of the arm. An *inferior external cutaneous branch* also goes through the outer head of the triceps with the preceding branch, then pierces the deep fascia near the insertion of the deltoid, and passes downward to be distributed to the skin on the outer side of the lower half of the arm, the elbow, and the outer back part of the forearm, communicating near its termination with the posterior branch of the musculo-cutaneous or external cutaneous nerve.

As the musculo-spiral nerve lies in contact with the back of the shaft of the humerus, paralysis of this nerve is a complication of fracture of that bone.

will be exposed. The skin is thin, can be raised in folds, and allows the superficial veins to be seen beneath it.

In the superficial fascia are found the radial, anterior ulnar, and median veins, and the musculo-cutaneous or external cutaneous nerve, the internal cutaneous nerve, cutaneous branches of the ulnar and median nerves, branches of the radial and ulnar arteries, and the superficial lymphatics.

The **radial vein** appears upon the front of the radial side of the forearm above its lower third, where it winds from behind forward and upward on the radial side of the forearm (generally superficial to the external cutaneous nerve) to form the cephalic vein at the elbow by junction with the median cephalic. It arises from the radial side of the dorsal venous arch of the hand, receives radicles from the back of the thumb and index finger, and communicates with the median vein.

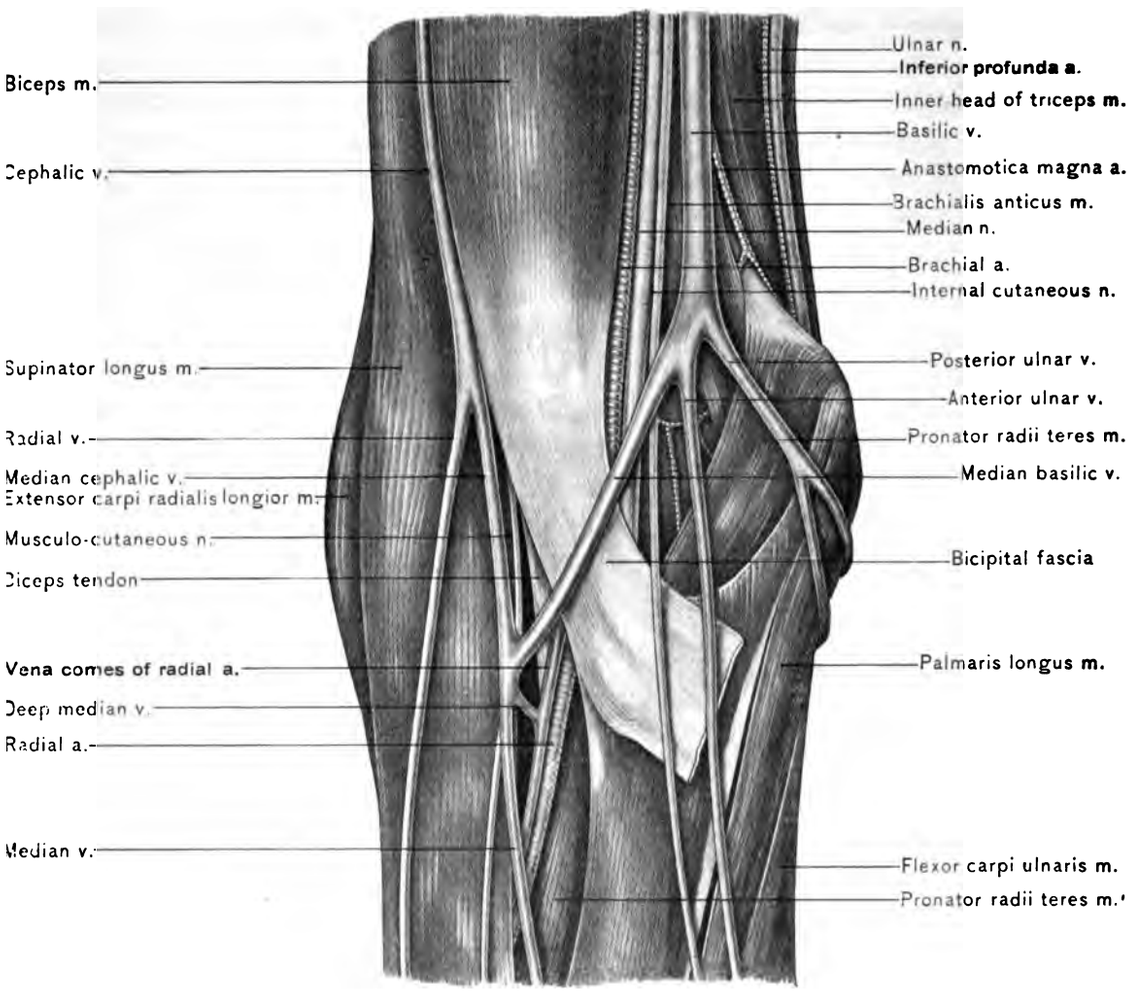
The **anterior ulnar vein** passes upward along the ulnar side of the forearm to within a short distance of the elbow, where it joins the posterior ulnar to form the common ulnar, which in turn almost immediately unites with the median basilic to form the basilic vein. It is formed by radicles at the wrist, and communicates with the median and posterior ulnar veins.

The **median vein** begins at, or a little above, the wrist and runs up the middle of the forearm. It collects blood from the palm of the hand and the front of the forearm, and communicates freely with the radial and anterior ulnar veins. Upon reaching the bend of the elbow, it communicates with the venæ comites of the radial artery by means of the deep median vein and at once divides into two branches—the median cephalic and median basilic.

The **musculo-cutaneous** or external cutaneous nerve becomes superficial a short distance above the elbow on the outer side of the tendon of the biceps, and passes downward upon the outer side of the front of the forearm, ending upon the ball of the thumb (thenar eminence). It gives off, just below the elbow, a posterior branch which supplies the outer side of the back of the forearm. The anterior branch—the continuation of the musculo-cutaneous—lies in front of the radial artery in the lower part of the forearm and communicates with a branch of the radial nerve. It terminates in filaments to the skin over the ball of the thumb.

The **anterior branch of the internal cutaneous nerve** enters the forearm at the inner side of the front of the elbow, either in front of, or behind, the median basilic vein; thence it continues downward upon the ulnar side of the front of the

PLATE XXXIV.


Biceps m.
Cephalic v.
Supinator longus m.
Radial v.
Median cephalic v.
Extensor carpi radialis longior m.
Musculo-cutaneous n.
Biceps tendon
Vena comes of radial a.
Deep median v.
Radial a.
Median v.
Ulnar n.
Inferior profunda a.
Inner head of triceps m.
Basilic v.
Anastomotica magna a.
Brachialis anticus m.
Median n.
Brachial a.
Internal cutaneous n.
Posterior ulnar v.
Anterior ulnar v.
Pronator radii teres m.
Median basilic v.
Bicipital fascia
Palmaris longus m.
Flexor carpi ulnaris m.
Pronator radii teres m.

A cutaneous branch of the median nerve pierces the deep fascia about two inches above the middle of the wrist and passes to the palm.

The **superficial arteries** of the forearm are small cutaneous branches from the radial and ulnar arteries.

The **superficial lymphatics** accompany the superficial veins, and are more numerous upon the ulnar than upon the radial side of the forearm. They commence at the ends of the fingers—two on the palmar and two on the dorsal surface. Those on the palmar surface of the fingers join an arch in the palm of the hand, from which arise the vessels which accompany the anterior ulnar, the median, and radial veins; those on the dorsal aspect of the fingers form a plexus on the back of the hand, from which vessels pass up the back of the forearm and around either side to empty into those on the anterior surface of the forearm. The greater number of these vessels pass upward on the inner side of the arm with the basilic vein. A few accompany the cephalic vein.

DISSECTION.—Trace the superficial veins in the superficial layer of the superficial fascia and remove this fascia in one flap like that of the skin. Follow the nerves through the under surface of the fascia. The deep fascia is now exposed.

The **deep fascia** of the forearm is continuous with that of the arm, and composed of circular and oblique white fibers bound together by a few longitudinal fibers. It is attached to the bony prominences of the forearm, and sends prolongations between the muscles, separating them and affording additional surfaces for their origin. It is most dense at the back of the forearm, least so in front of the upper part of the forearm, and intermediate in thickness above and at the wrist. In the last-named location it forms the posterior annular ligament and is continuous with the anterior annular ligament. It is reinforced by tendinous accessions from the biceps (bicipital aponeurosis), brachialis anticus, and triceps. Its numerous intermuscular septa at the elbow, beginning at the limited area of the surface of the internal condyle and expanding, form cone-shaped aponeurotic cavities for the origins of many muscles. A transverse intermuscular septum divides the muscles of the forearm into a superficial and a deep group. Besides smaller apertures for the passage of cutaneous vessels and nerves,

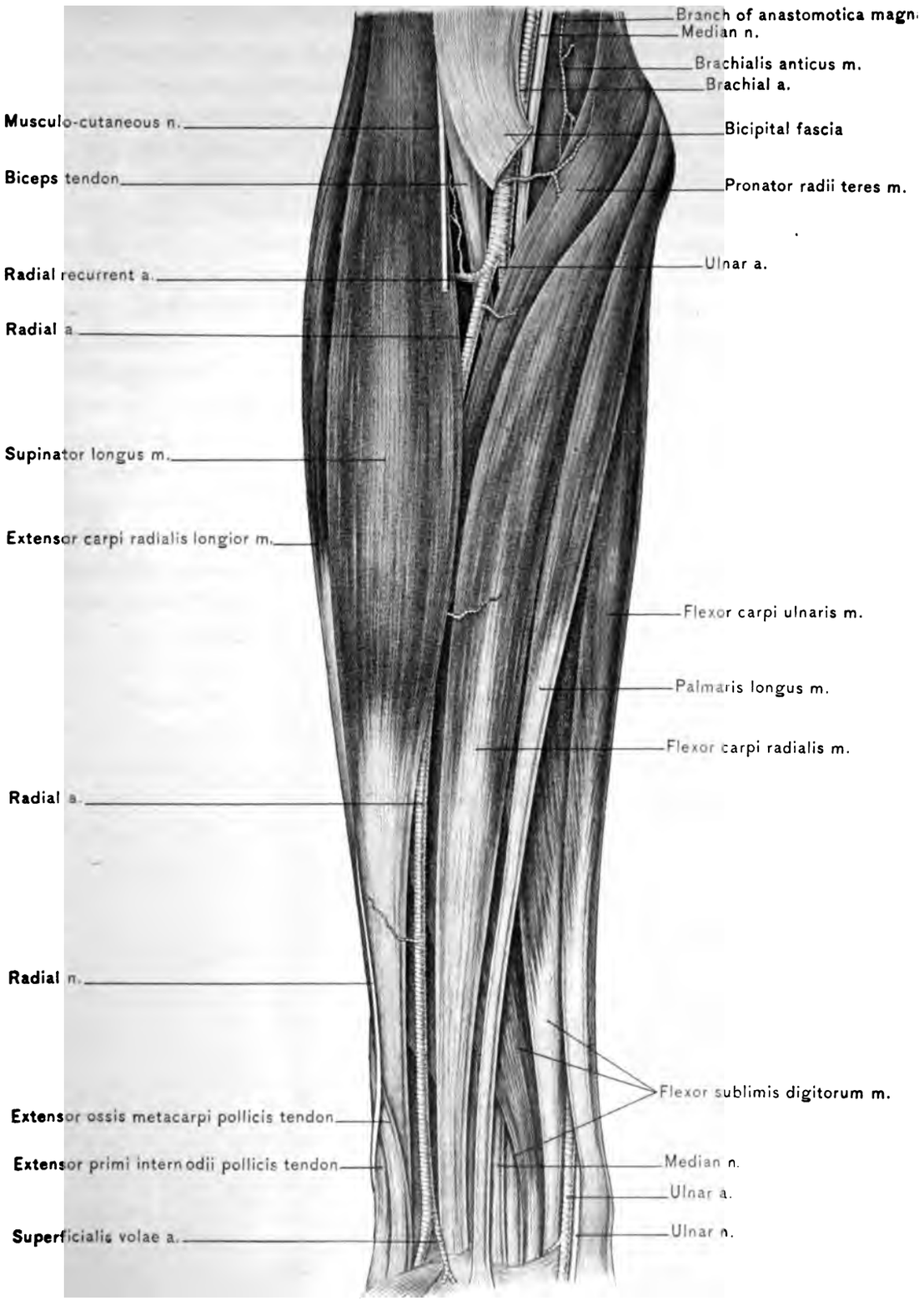
better advantage by reflecting it from below upward. A similar difficulty is encountered at the buttock in the removal of the deep fascia from the great gluteal muscle, the main difference between the two fasciæ being that, in the gluteal region the deep fascia sends septa into the muscle itself, while in the forearm the septa pass between the muscles.

The **triangle at the bend of the elbow.**—Upon the removal of the deep fascia, a triangle is exposed at the bend of the elbow. This triangle is bounded above by an imaginary line which is drawn between the condyles of the humerus and forms the base; externally, by the supinator longus; and internally, by the pronator radii teres. The apex of the triangle is at the point where the supinator longus crosses the pronator radii teres. The floor is formed by the brachialis anticus and supinator brevis muscles, and the deep fascia forms its roof. Within this triangle, when its lateral boundaries are displaced,—the supinator longus outward and pronator radii teres inward,—the following structures are seen from within outward: The anterior ulnar recurrent artery, the median nerve, the brachial artery, its venæ comites, the two terminal branches of the brachial or the radial and ulnar arteries, their venæ comites, the deep median vein, the common interosseous artery, the tendon of the biceps, the radial recurrent artery, and the musculo-spiral nerve. In rupture of the biceps muscle the tendon can be distinctly felt loose and free and can be manipulated in this space. The effusion of blood renders approximation impracticable without operative interference.

The **Muscles** of the forearm may be divided into groups: an inner or anterior, and an outer or posterior; the former including the pronators and flexors; the latter, the supinators and extensors. The inner group chiefly arises by a common tendon from the internal condyle and internal condyloid ridge, and the outer, from the external condyle and the external condyloid ridge.

The **pronator radii teres,** the shortest muscle of this group, arises by two heads—a large or superficial, and a small or deep. The large or superficial head springs from the anterior surface of the humerus above the internal condyle, an intermuscular septum separating it from the flexor carpi radialis and the deep fascia of the forearm; the small or deep head arises as a narrow bundle of fibers from the inner aspect of the coronoid process of the ulna. The two heads unite at

PLATE XX


Branch of anastomotica magn.
Median n.
Brachialis anticus m.
Brachial a.
Musculo-cutaneous n.
Bicipital fascia
Biceps tendon
Pronator radii teres m.
Radial recurrent a.
Ulnar a.
Radial a.
Supinator longus m.
Extensor carpi radialis longior m.
Flexor carpi ulnaris m.
Palmaris longus m.
Flexor carpi radialis m.
Radial a.
Radial n.
Flexor sublimis digitorum m.
Extensor ossis metacarpi pollicis tendon
Extensor primi internodii pollicis tendon
Median n.
Ulnar a.
Superficialis volae a.
Ulnar n.

the ulnar border is in relation with the flexor carpi radialis. Its under surface is in contact with the brachialis anticus and flexor sublimis digitorum muscles, the median nerve, and ulnar vessels. The inner head of the muscle separates the median nerve in front from the ulnar vessels behind.

BLOOD SUPPLY.—Its nutriment is derived from the radial, ulnar, and anastomotica magna arteries.

NERVE SUPPLY.—From the median nerve.

ACTION.—Pronates and flexes the forearm.

The **flexor carpi radialis** arises by the common tendon from the internal condyle, also from the deep fascia and contiguous surfaces of the adjacent intermuscular septa. It passes down the forearm to the radial side of the front of the wrist, where it traverses a canal in the anterior annular ligament and a groove upon the trapezium, and is ultimately attached to the anterior surface of the base of the metacarpal bone of the index finger. A small slip passes to the base of the metacarpal bone of the middle finger. The groove in the trapezium is converted into a canal by a fibrous sheath, the canal being lined by a synovial membrane. This muscle is tendinous in its lower three-fifths; its belly is full and fusiform. It is superficial, with the exception of the small portion of the tendon which enters the annular ligament; it lies upon the flexor sublimis digitorum, the flexor longus pollicis, and the wrist-joint. Externally, it is in contact with the pronator radii teres, and in its lower half is very near the radial vessels; internally, it lies against the palmaris longus muscle, above. Above the wrist the median nerve is on the inner side of its tendon.

BLOOD SUPPLY.—Its nutriment is derived from the radial artery and ulnar recurrent artery.

NERVE SUPPLY.—Derived from the median nerve.

ACTION.—Its main function is to flex the wrist; it also aids in flexion of the elbow, and with the hand supinated it aids in pronation.

The **palmaris longus,** often absent, is slender and spindle-shaped. It arises by the common tendon from the inner condyle, also from the deep fascia and the adjacent intermuscular septa. Its slender tendon passes over the anterior annular ligament to terminate in an expanded prolongation, which is continuous with the central portion of the palmar fascia, the deep fascia over the thenar eminence, and the anterior annular ligament at the base of that eminence. It is subcutaneous, except at its origin, where it is partly overlapped by the flexor carpi radialis. It lies upon the flexor sublimis digitorum, the median nerve, and

NERVE SUPPLY.—From the median nerve.

ACTION.—It makes tense the palmar fascia, flexes the wrist, and aids slightly in elbow flexion.

The **flexor carpi ulnaris,** a long and flat muscle, embraces the outer side of the upper part of the shaft of the ulna. It arises by two heads—one by the common tendon from the internal condyle, the other from the inner aspect of the olecranon process—and partly by an aponeurosis continued down from the upper portion of the posterior border of the ulna. Fibers also arise from the overlying deep fascia and the intermuscular septum between this muscle and the flexor sublimis digitorum. The interval between the condyloid and olecranon heads is spanned by a tendinous arch, under which pass the ulnar nerve and the posterior ulnar recurrent artery. The muscle terminates in a tendon which runs along its anterior margin, the lower fibers passing to the tendon obliquely downward and forward. It is inserted into the pisiform bone, with more or less fibrous connection with the anterior annular ligament, the uneiform bone, and the base of the metacarpal bone of the little finger. It is the only muscle of the forearm attached to carpal bones. Its anterior and inner surfaces are subcutaneous, and intimately attached to the deep fascia over much of their extent, especially near the posterior border of the ulna. It lies upon the flexor sublimis digitorum and flexor profundus digitorum muscles, and the ulnar vessels and nerve. Its tendon is the guide for ligation of the ulnar artery, which it overlaps. Externally, it is in contact with the belly of the palmaris longus muscle and the ulnar vessels and nerve.

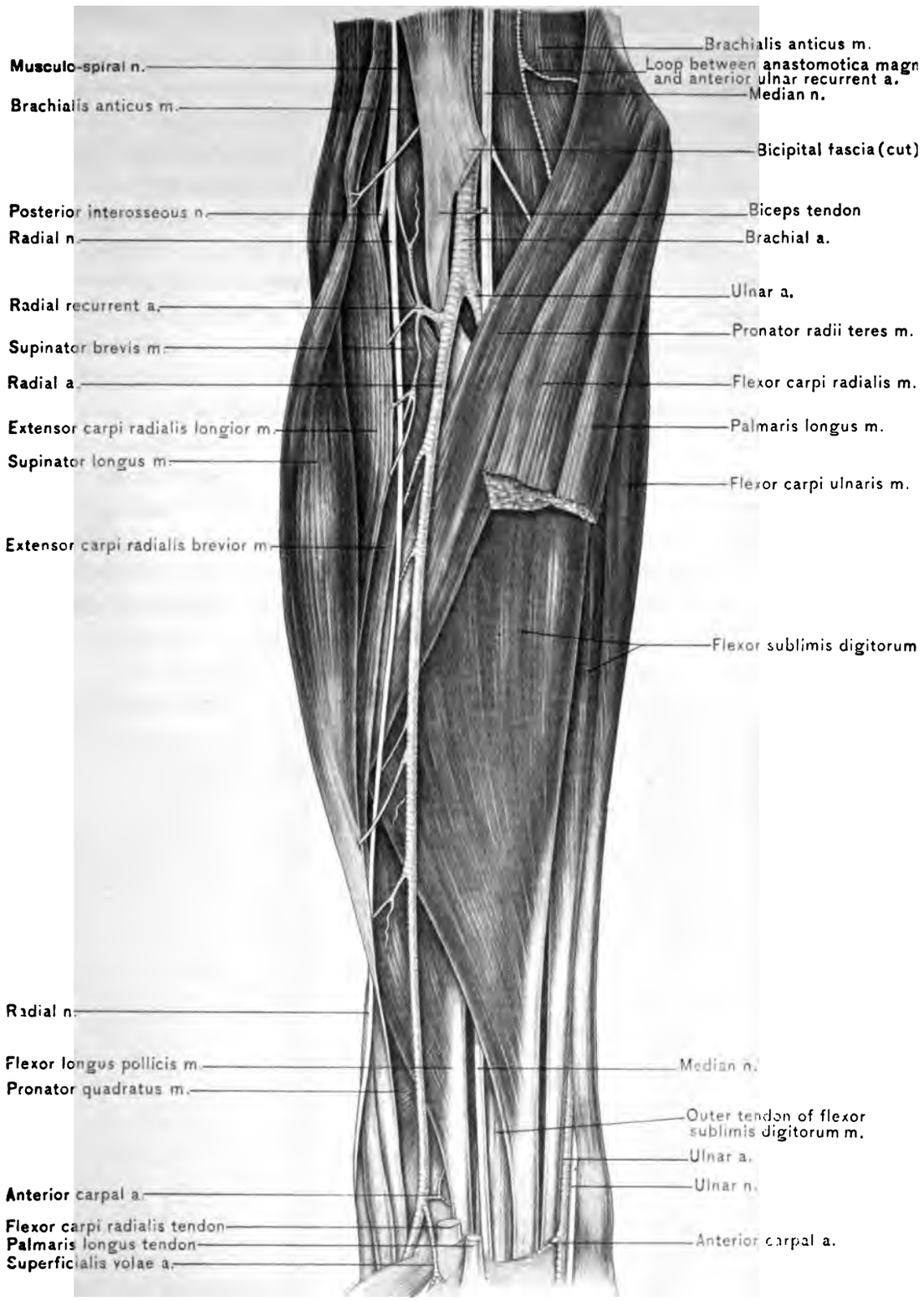
BLOOD SUPPLY.—From the ulnar artery.

NERVE SUPPLY.—From the ulnar nerve.

ACTION.—It flexes and adducts the hand, and slightly flexes the forearm on the arm.

Owing to its extensive connection with the ulna, this muscle can not retract

PLATE XXXV


Musculo-spiral n.
Brachialis anticus m.
Posterior interosseous n.
Radial n.
Radial recurrent a.
Supinator brevis m.
Radial a.
Extensor carpi radialis longior m.
Supinator longus m.
Extensor carpi radialis brevior m.
Radial n.
Flexor longus pollicis m.
Pronator quadratus m.
Anterior carpal a.
Flexor carpi radialis tendon
Palmaris longus tendon
Superficialis volae a.
Brachialis anticus m.
Loop between anastomotica magn and anterior ulnar recurrent a.
Median n.
Bicipital fascia (cut)
Biceps tendon
Brachial a.
Ulnar a.
Pronator radii teres m.
Flexor carpi radialis m.
Palmaris longus m.
Flexor carpi ulnaris m.
Flexor sublimis digitorum
Median n.
Outer tendon of flexor sublimis digitorum m.
Ulnar a.
Ulnar n.
Anterior carpal a.

which pass beneath the anterior annular ligament, where they are arranged in two pairs, one behind the other. The anterior pair go to the middle and ring fingers, and the posterior pair to the index and little fingers. The tendons are inserted into the middle of the sides of the second phalanges of the four fingers. Each tendon splits to permit the passage of the tendon of the flexor profundus digitorum muscle between its segments, which will be seen in the dissection of the hand.

This muscle is covered by the pronator radii teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris, also by the radial vessels and nerve and the deep fascia. It rests upon the flexor profundus digitorum, and the flexor longus pollicis, the ulnar vessels and nerve, and the median nerve. Its inner edge is against the flexor carpi ulnaris. Externally, it is overlapped by the lower end of the pronator radii teres.

BLOOD SUPPLY.—From the radial and ulnar arteries.

NERVE SUPPLY.—From the median nerve.

ACTION.—It flexes the proximal interphalangeal, the metacarpo-phalangeal, and wrist joints, and assists slightly in flexion of the elbow.

DISSECTION.—Displace the supinator longus outward in order to expose the radial artery and nerve in the upper part of the forearm. Separate the flexor carpi ulnaris from the flexor sublimis digitorum and study the relations of the ulnar vessels and nerve. Then sever the pronator radii teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum, about one and one-half or two inches below the internal condyle, without cutting the median nerve, ulnar artery, or ulnar nerve. Reflect these muscles in order to obtain a view of the structures beneath—namely, the flexor profundus digitorum, flexor longus pollicis, pronator quadratus, median nerve, ulnar vessels, and anterior interosseous vessels and nerve.

The **flexor profundus digitorum** arises from the upper two-thirds of the front and inner side of the shaft of the ulna, and at its upper end interdigitates with the brachialis anticus in the same manner as that muscle at its origin does with the deltoid. It also arises from the inner side of the coronoid process of the ulna, and by the aponeurosis from the upper two-thirds of the posterior border of the ulna, in common with the ulnar origin of the flexor carpi ulnaris, and from the ulnar half of the interosseous membrane. It divides into four tendons, which pass down the forearm and continue, side by side, under the anterior annular ligament, behind the tendon of the flexor sublimis digitorum to the bases of the terminal phalanges, passing between the segments of the tendons of the flexor sublimis digitorum. A lumbricalis muscle is attached to each one of these tendons in the palm. The flexor profundus digitorum muscle lies beneath the flexor sublimis digitorum and flexor carpi radialis muscles, the ulnar vessels and nerve, and the median nerve.

LATE XXXVII.

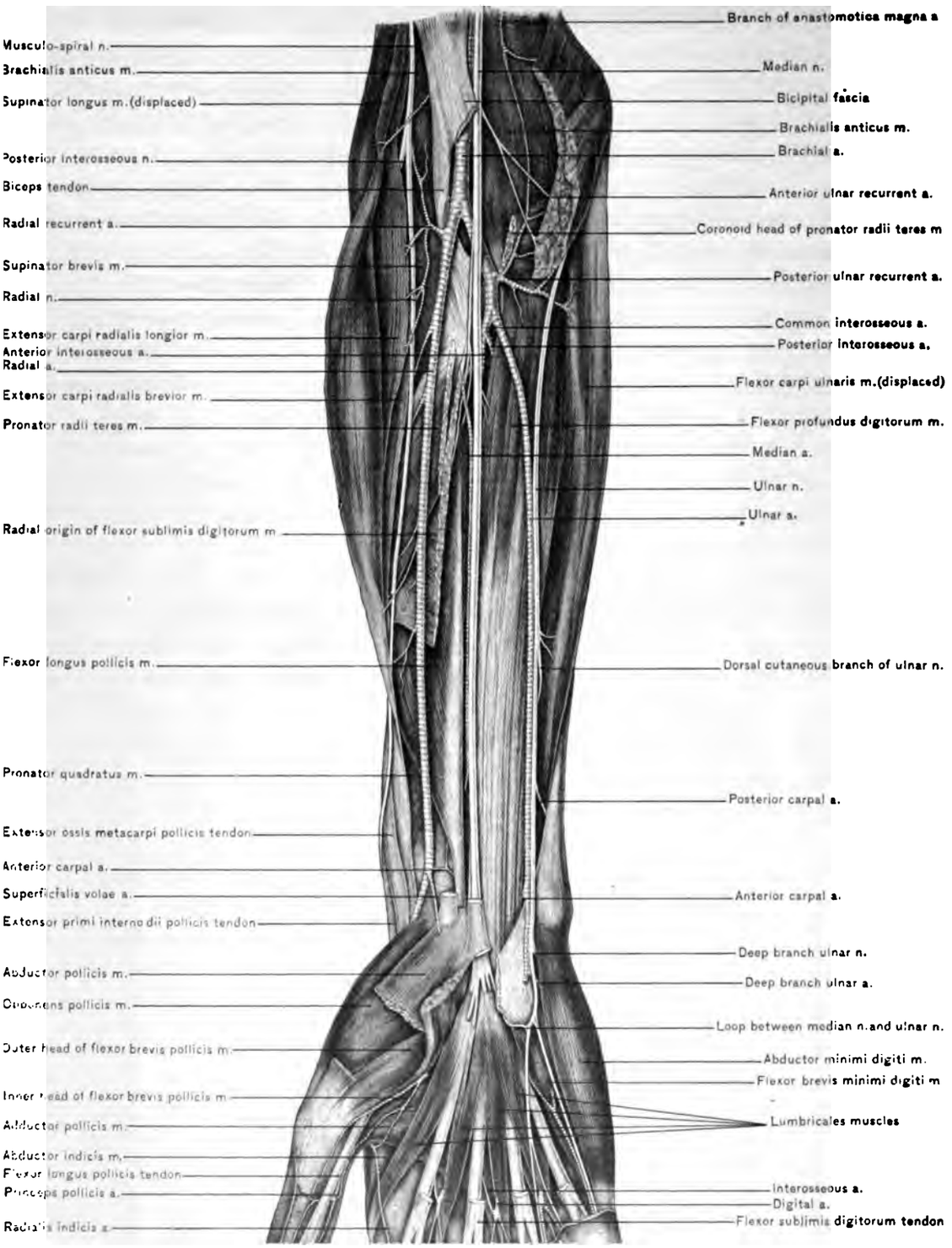
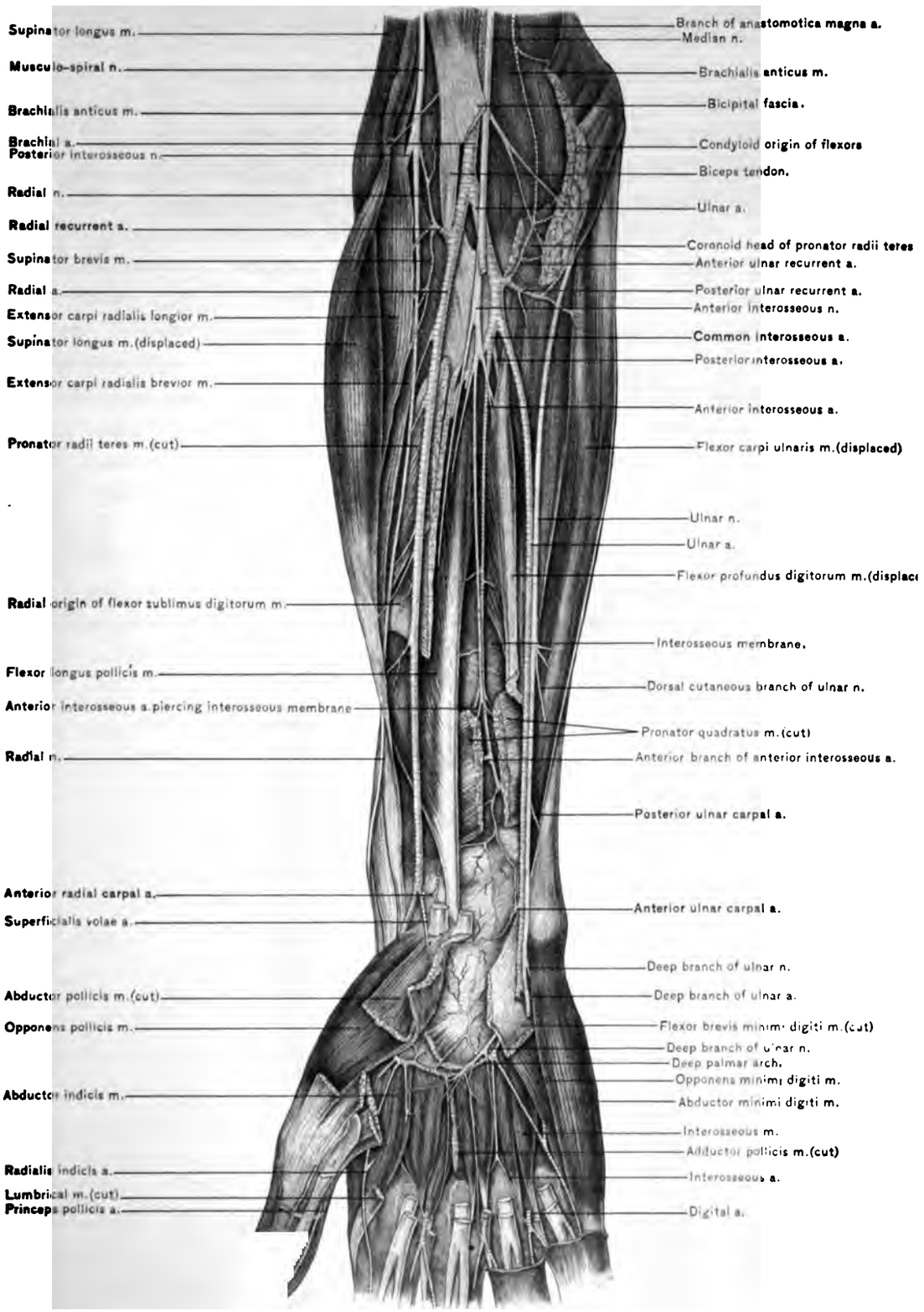

Musculo-spiral n.
Brachialis anticus m.
Supinator longus m.(displaced)
Posterior interosseous n.
Biceps tendon
Radial recurrent a.
Supinator brevis m.
Radial n.
Extensor carpi radialis longior m.
Anterior interosseous a.
Radial a.
Extensor carpi radialis brevior m.
Pronator radii teres m.
Radial origin of flexor sublimis digitorum m.
Flexor longus pollicis m.
Pronator quadratus m.
Extensor ossis metacarpi pollicis tendon
Anterior carpal a.
Superficialis volae a.
Extensor primi internodii pollicis tendon
Abductor pollicis m.
Opponens pollicis m.
Outer head of flexor brevis pollicis m.
Inner head of flexor brevis pollicis m.
Adductor pollicis m.
Abductor indicis m.
Flexor longus pollicis tendon
Princeps pollicis a.
Radialis indicis a.
Branch of anastomotica magna a.
Median n.
Bicipital fascia
Brachialis anticus m.
Brachial a.
Anterior ulnar recurrent a.
Coronoid head of pronator radii teres m.
Posterior ulnar recurrent a.
Common interosseous a.
Posterior interosseous a.
Flexor carpi ulnaris m.(displaced)
Flexor profundus digitorum m.
Median a.
Ulnar n.
Ulnar a.
Dorsal cutaneous branch of ulnar n.
Posterior carpal a.
Anterior carpal a.
Deep branch ulnar n.
Deep branch ulnar a.
Loop between median n.and ulnar n.
Abductor minimi digiti m.
Flexor brevis minimi digiti m.
Lumbricales muscles
Interosseous a.
Digital a.
Flexor sublimis digitorum tendon

PLATE XXX


Supinator longus m.
Musculo-spiral n.
Brachialis anticus m.
Brachial a.
Posterior interosseous n.
Radial n.
Radial recurrent a.
Supinator brevis m.
Radial a.
Extensor carpi radialis longior m.
Supinator longus m.(displaced)
Extensor carpi radialis brevior m.
Pronator radii teres m.(cut)
Radial origin of flexor sublimus digitorum m.
Flexor longus pollicis m.
Anterior interosseous a.piercing interosseous membrane
Radial n.
Anterior radial carpal a.
Superficialis volae a.
Abductor pollicis m.(cut)
Opponens pollicis m.
Abductor indicis m.
Radialis indicis a.
Lumbrical m.(cut)
Princeps pollicis a.
Branch of anastomotica magna a.
Median n.
Brachialis anticus m.
Bicipital fascia.
Condyloid origin of flexors
Biceps tendon.
Ulnar a.
Coronoid head of pronator radii teres
Anterior ulnar recurrent a.
Posterior ulnar recurrent a.
Anterior interosseous n.
Common interosseous a.
Posterior interosseous a.
Anterior interosseous a.
Flexor carpi ulnaris m.(displaced)
Ulnar n.
Ulnar a.
Flexor profundus digitorum m.(displace
Interosseous membrane.
Dorsal cutaneous branch of ulnar n.
Pronator quadratus m.(cut)
Anterior branch of anterior interosseous a.
Posterior ulnar carpal a.
Anterior ulnar carpal a.
Deep branch of ulnar n.
Deep branch of ulnar a.
Flexor brevis minimi digiti m.(cut)
Deep branch of ulnar n.
Deep palmar arch.
Opponens minimi digiti m.
Abductor minimi digiti m.
Interosseous m.
Adductor pollicis m.(cut)
Interosseous a.
Digital a.

ACTION.—It pronates the forearm.

The **interosseous membrane** extends between the interosseous margins of the radius and ulna, firmly connecting the shafts of those bones and forming a dividing wall between the front and the back of the forearm. It extends upward to within an inch of the tuberosity of the radius, and downward to the inferior radio-ulnar articulation. Its fibers pass downward and inward from the edge of the radius to the radial margin of the ulna. It affords attachment to the deep muscles of the front and back of the forearm, supports the anterior interosseous artery and its venæ comites, and the anterior interosseous nerve. The anterior interosseous artery pierces the membrane about one and one-half inches above its lower end. It is relaxed in pronation of the forearm. The posterior interosseous vessels pass backward above its upper margin.

The **oblique ligament** is a round, fibrous cord, connected above to the tubercle of the ulna located at the base of its coronoid process, whence it extends downward and outward to the radius to a point a little below the bicipital tuberosity. It is connected by a thin membrane to the upper border of the interosseous membrane. Its direction forms a right angle with that of the fibers of the interosseous membrane. Sometimes it is absent.

The **radial artery** begins at the bifurcation of the brachial, about one-half of an inch below the elbow-joint. Its course is more nearly in a direct line with the parent trunk than is that of the ulnar artery, and is represented by a line drawn from a point one-half of an inch below the middle of the bend of the elbow to the inner side of the base of the styloid process of the radius. It passes down the radial side of the forearm along the ulnar margin of the supinator longus, which is the muscle of reference for its ligation, and is overlapped thereby in the upper one-third or one-fourth of its course. At the wrist or base of the thumb it turns backward over the external lateral ligament of the wrist-joint beneath the extensors of the thumb, and then passes between the two heads of the first dorsal interosseous muscle (abductor indicis) into the palm of the hand, where it assists in forming the deep palmar arch. It is superficial in the forearm, except at its upper part, where it is covered by the supinator longus. From above downward it rests upon the tendon of the biceps, the supinator brevis, the pronator radii teres, the radial head of the flexor sublimis

closely related to its lower part as it courses around the wrist. Its branches in the forearm are the radial recurrent, muscular, superficialis volæ, and the anterior carpal; at the wrist, the posterior carpal, the metacarpal, the dorsalis pollicis, and the dorsalis indicis; and in the hand, the princeps pollicis, radialis indicis, perforating, palmar interosseous, and recurrent carpal. We will, at this time, consider only those branches given off in the forearm.

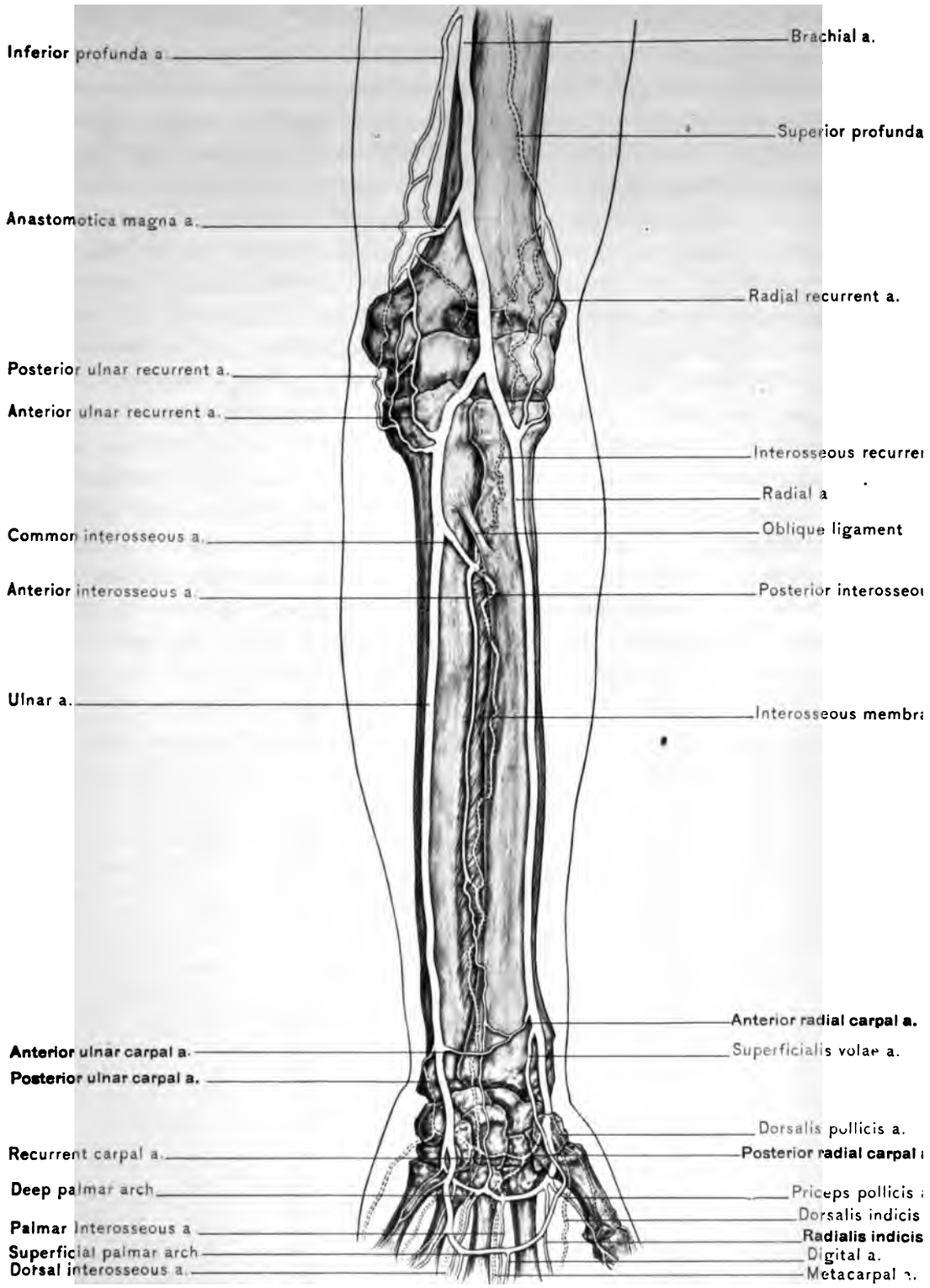
The **radial recurrent** arises from the outer side of the radial artery, passes downward between the supinator brevis and supinator longus muscles and between the radial and posterior interosseous nerves; thence upward, in company with the musculo-spiral nerve, between the brachialis anticus and supinator longus, both of which it in part supplies. It anastomoses with the terminal branches of the superior profunda in front of the external condyle and between the two last-named muscles. From its arch it sends muscular branches to the supinator and the extensor muscles, some passing beneath the latter to anastomose with the interosseous recurrent branch of the posterior interosseous. It also supplies the elbow-joint.

The *muscular branches* arise from the radial in its downward course and supply the muscles upon the radial side of the forearm.

The **superficialis volæ** arises from the radial artery near the wrist, and passes over the ball of the thumb. Sometimes it runs beneath the abductor pollicis muscle. It supplies the muscles of the ball of the thumb and often anastomoses with the ulnar artery to assist in the formation of the superficial palmar arch. When the superficialis volæ arises higher than usual and runs beside the radial, it would give the palpating finger the sensation of a double pulse.

The **anterior carpal** arises from the radial artery near the lower margin of the pronator quadratus, whence it passes inward to anastomose with the anterior

PLATE XX


Inferior profunda a.
Brachial a.
Superior profunda
Anastomotica magna a.
Radial recurrent a.
Posterior ulnar recurrent a.
Anterior ulnar recurrent a.
Interosseous recurrer
Radial a
Common interosseous a.
Oblique ligament
Anterior interosseous a.
Posterior interosseo
Ulnar a.
Interosseous membra
Anterior radial carpal a.
Anterior ulnar carpal a.
Superficialis volae a.
Posterior ulnar carpal a.
Dorsalis pollicis a.
Recurrent carpal a.
Posterior radial carpal
Deep palmar arch
Priceps pollicis
Dorsalis indicis
Palmar interosseous a
Radialis indicis
Superficial palmar arch
Digital a.
Dorsal interosseous a.
Metacarpal

crosses the anterior annular ligament on the radial side of the pisiform bone, and runs across the palm, forming the superficial palmar arch, which is usually completed by anastomosis with the superficialis volæ. The ulnar artery is deep in its upper half, being covered by all of the superficial flexors except the flexor carpi ulnaris; in its lower half it is more superficial, being overlapped by the tendon of the flexor carpi ulnaris, while immediately above the wrist it is subcutaneous, and lies between the tendon of the flexor carpi ulnaris and the innermost tendon of the flexor sublimis digitorum. It lies, from above downward, upon the brachialis anticus, flexor profundus digitorum, and the anterior annular ligament. It has two venæ comites. At its upper part the median nerve crosses in front of it, while the ulnar nerve is upon the inner side of its lower two-thirds. In the upper third of the course of the artery the ulnar nerve lies some distance to its ulnar side. When the ulnar artery has a high origin from the brachial, it usually lies upon the superficial flexor muscles, instead of beneath them, and is thus more liable to injury. Its branches in the forearm are the anterior ulnar recurrent, posterior ulnar recurrent, common interosseous, and muscular; at the wrist, the anterior and posterior carpal; in the hand, the deep or communicating branch; it continues as the superficial palmar arch. As in the case of the radial artery, we will now consider only the branches given off in the forearm.

The **anterior ulnar recurrent artery** arises from the ulnar, immediately below its origin, and passes inward and upward upon the brachialis anticus, and, behind the pronator radii teres, to the front of the inner condyle of the humerus, where it anastomoses with the anastomotica magna and the inferior profunda arteries.

The **posterior ulnar recurrent artery,** larger than the anterior ulnar recurrent, arises below that vessel and passes inward and backward under the flexor sublimis digitorum. It then courses between the two heads of the flexor carpi ulnaris, in relation with the ulnar nerve, to the back of the inner condyle. It supplies the elbow-joint, ulnar nerve, and adjacent muscles, and anastomoses with the inferior profunda, anastomotica magna, and interosseous recurrent arteries.

The **common interosseous artery** is the largest and shortest branch of the ulnar. It is given off opposite the tuberosity of the radius, whence it passes downward and outward to the upper margin of the interosseous membrane and divides into the anterior and posterior interosseous arteries.

The **anterior interosseous artery,** accompanied by venæ comites and the

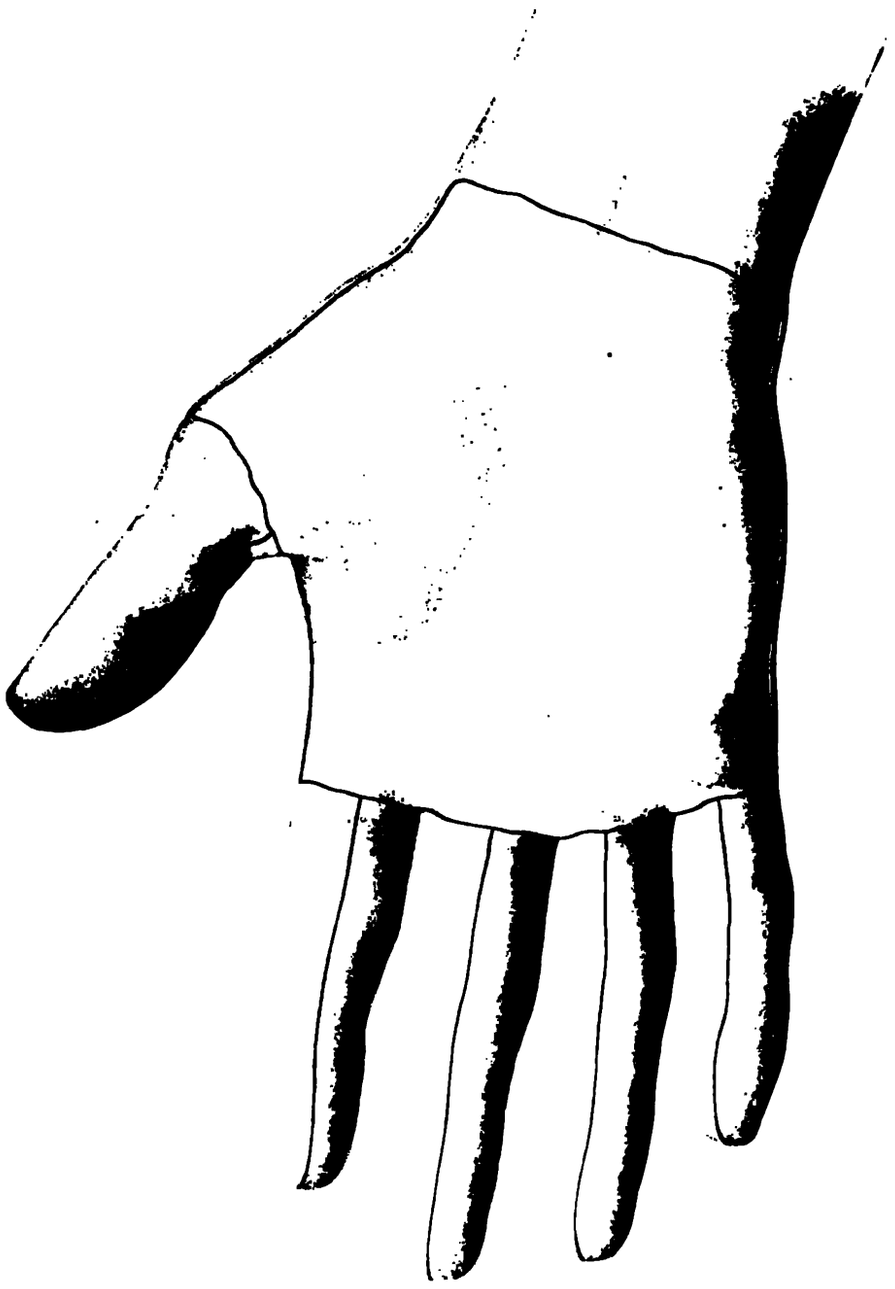
the upper border of the pronator quadratus, to reach the back of the forearm. Under the upper border of the pronator quadratus it gives off a branch which supplies this muscle and anastomoses with the anterior carpal branches of the radial and ulnar and the recurrent carpal branches of the deep palmar arch. In the upper part of the forearm it also gives off a long slender branch which accompanies the median nerve and is called the *comes nervi mediani*, or *median artery*. This is sometimes quite large, and then assists in the formation of the superficial palmar arch. The posterior interosseous will be described with the back of the forearm.

The *muscular branches*, variable in number, supply the adjacent muscles.

The **anterior carpal artery** is a small branch given off immediately above the anterior annular ligament. It passes outward, beneath the tendons of the flexor profundus digitorum, and anastomoses with the anterior carpal branch of the radial, with derivatives of the anterior interosseous, and the recurrent carpal branches of the deep palmar arch. It forms, with the corresponding branch of the radial, the pre-carpal arch. The posterior carpal branch will be described with the back of the wrist and hand.

The **median nerve** enters the forearm upon the inner side of the brachial artery, passes between the two heads of the pronator radii teres, the deep head of which separates it from the ulnar artery, and continues straight down the forearm to the wrist, upon the flexor profundus digitorum, covered by the flexor sublimis digitorum. Near the wrist it lies between the outer tendon of the flexor sublimis digitorum and the tendon of the flexor carpi radialis; it then passes under the anterior annular ligament, resting upon the flexor tendons. It is accompanied and supplied by the median artery. In the forearm it gives off articular, muscular,

PLATE XL.



skin of the palm, except on the ulnar side, and communicates with the ulnar palmar cutaneous branch.

The **radial nerve** is one of the terminal branches of the musculo-spiral. It passes along the front of the outer side of the forearm, accompanying the radial artery along the outer side of its middle one-third. In the upper part of its course it is overlapped by the belly of the supinator longus, and about three inches above the wrist curves backward under the tendon of that muscle and pierces the deep fascia, at the outer border of the forearm, to divide into an external and an internal branch. These supply the skin of the back of the hand and fingers.

The **ulnar nerve,** emerging from between the olecranon and the internal condyle of the humerus in the upper part of the forearm, passes down the anterior and inner side of the forearm upon the flexor profundus digitorum and beneath the belly of the flexor carpi ulnaris, while in the lower part of its course it lies to the radial side of the flexor carpi ulnaris muscle and its tendon. It has upon its radial side, as far down as the pisiform bone, the lower two-thirds of the ulnar artery. While in the forearm the ulnar nerve gives off articular, muscular, cutaneous, and dorsal cutaneous branches, and not infrequently it communicates with the median nerve.

The *articular branches* are given off, behind the internal condyle, to supply the elbow-joint, and, just above the carpus, to supply the wrist-joint.

Of the *muscular branches*, the one to the flexor carpi ulnaris arises in the upper part of the forearm; the other arises lower down, and passes to the inner part of the flexor profundus digitorum.

The *cutaneous branches* are two small nerves arising, by a common trunk, in the middle of the forearm. The shorter, and more superficial, descends to the skin of the ulnar side of the wrist, pierces the deep fascia, and joins a branch of the internal cutaneous, while the other, a deeper branch, accompanies the ulnar artery lying upon its anterior surface, to supply the skin of the ulnar side of the palm of the hand. This branch communicates with twigs from the median, and is called the *palmar cutaneous* branch.

The *dorsal cutaneous branch* arises about three inches above the wrist and passes backward, under the flexor carpi ulnaris, to the posterior surface of the wrist, where it pierces the deep fascia and divides into a communicating and two digital branches, which supply the skin and fascia of the ulnar side of the hand, both sides of the little finger, and the adjacent side of the ring finger. The communicating branch inosculates with the posterior branch of the internal cutaneous and the digital branches with the adjacent ones from the radial nerve.

THE FRONT OF THE HAND.

DISSECTION.—The skin has been incised across the front of the wrist. From the inner end of this incision make another along the ulnar border of the palm as far as the junction of the latter with the little finger. From the outer end of the transverse incision make a third along the radial border of the thenar eminence to the base of the first phalanx of the thumb, then around the palmar surface of the thumb, and along the radial border of the palm to its junction with the index finger. The flap of integument thus marked out is reflected downward, exposing the superficial fascia. In dissecting the thumb and fingers the skin is incised in the median line and reflected laterally. The skin of the palm is sensitive and well supplied with sweat glands, sebaceous glands being absent.

Superficial fascia.—The superficial fascia of the palm is dense and thin, and closely connects the skin with the deep fascia, resembling in this respect that of the scalp and sole of the foot. That covering the thenar and hypothenar eminences is more delicate. The fat in the palm of the hand presents a somewhat lobulated appearance, and when an incision is made through the skin, small masses of adipose tissue protrude through the opening. It contains the palmaris brevis muscle, the ulnar vessels and nerve, the palmar cutaneous branches of the ulnar and median nerves, and the superficial transverse ligament.

The **palmaris brevis muscle** is embedded in the granular superficial fascia on the ulnar side of the palm. It consists of a series of slightly divergent fasciculi, which arise from the central palmar fascia and the anterior annular ligament, pass over the hypothenar eminence, and are inserted into the skin of the ulnar border of the palm.

NERVE SUPPLY.—From the ulnar nerve.

The ulnar vessels and nerve occupy the superficial fascia on the radial side of the pisiform bone, where their deep branches are given off.

Palmar cutaneous nerves.—Trace the palmar cutaneous branches of the median, radial, and ulnar nerves to their termination. That of the *median* passes between the tendons of the flexor carpi radialis and palmaris longus and over the

PLATE X

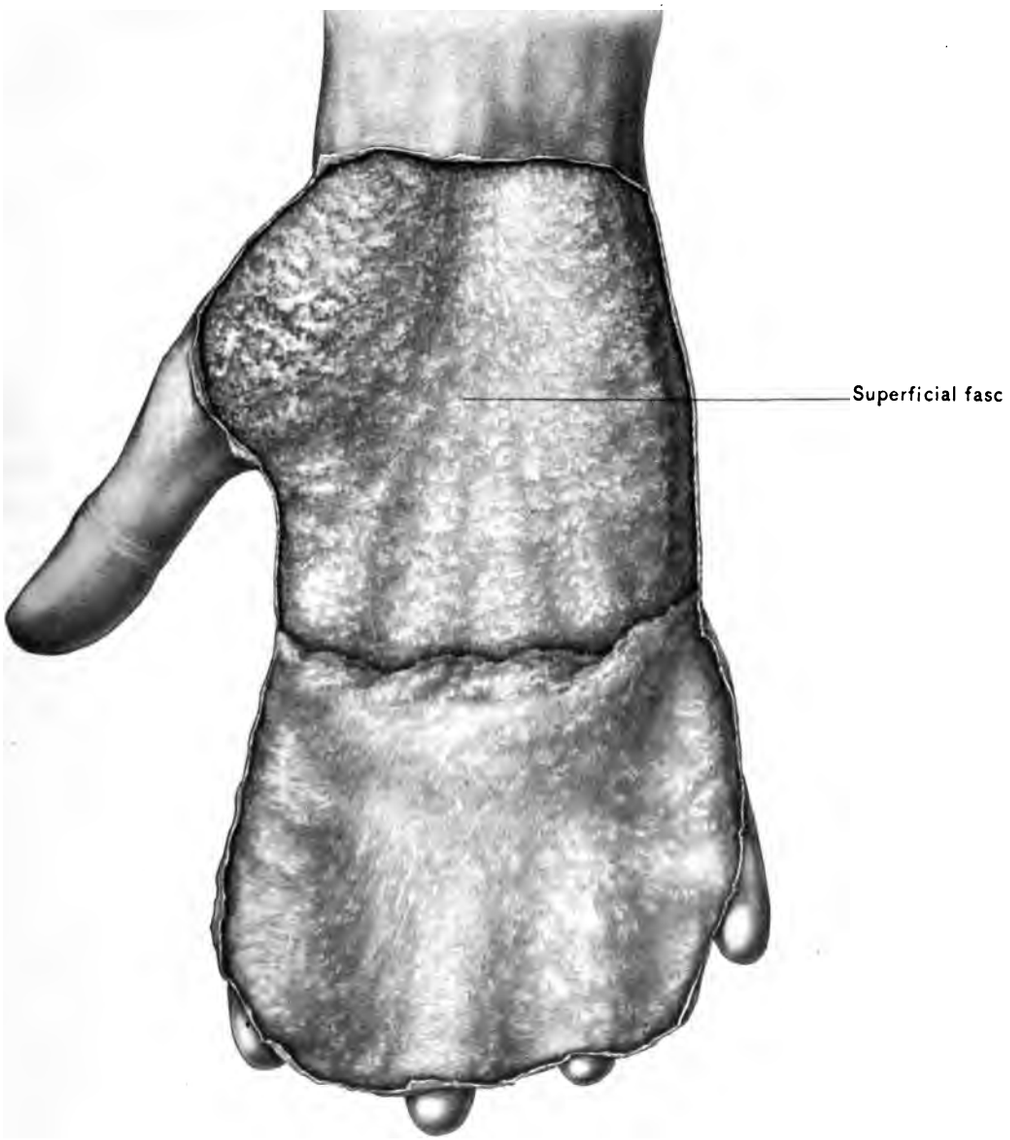
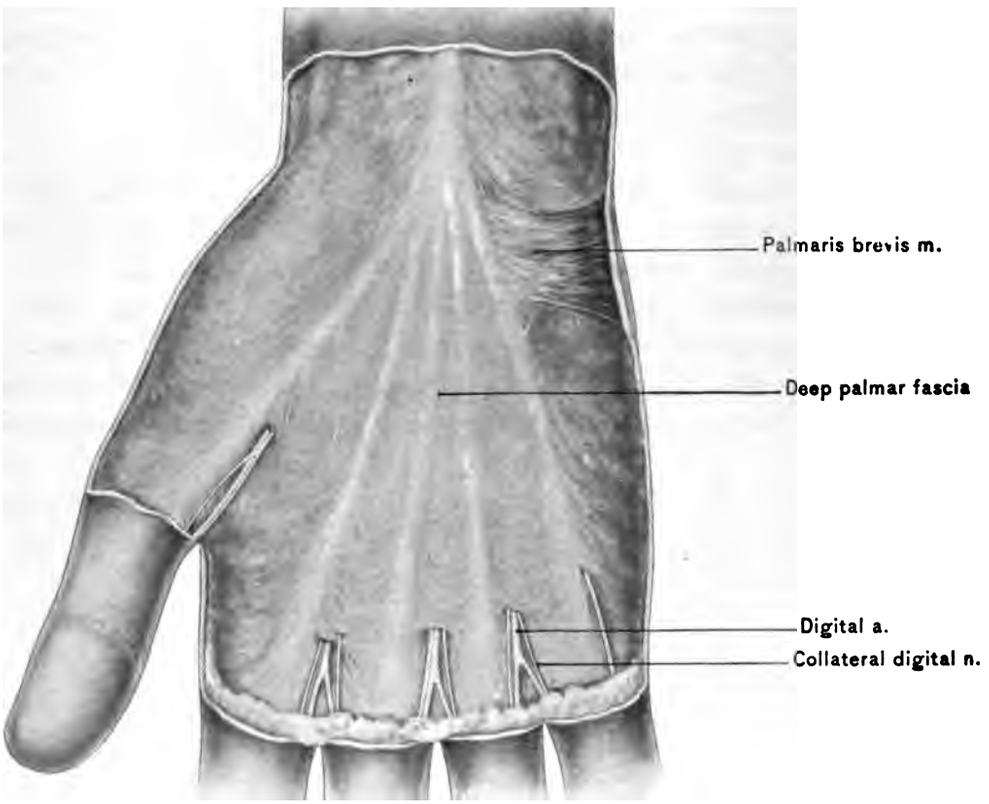


PLATE XLII.


Palmaris brevis m.
Deep palmar fascia
Digital a.
Collateral digital n.

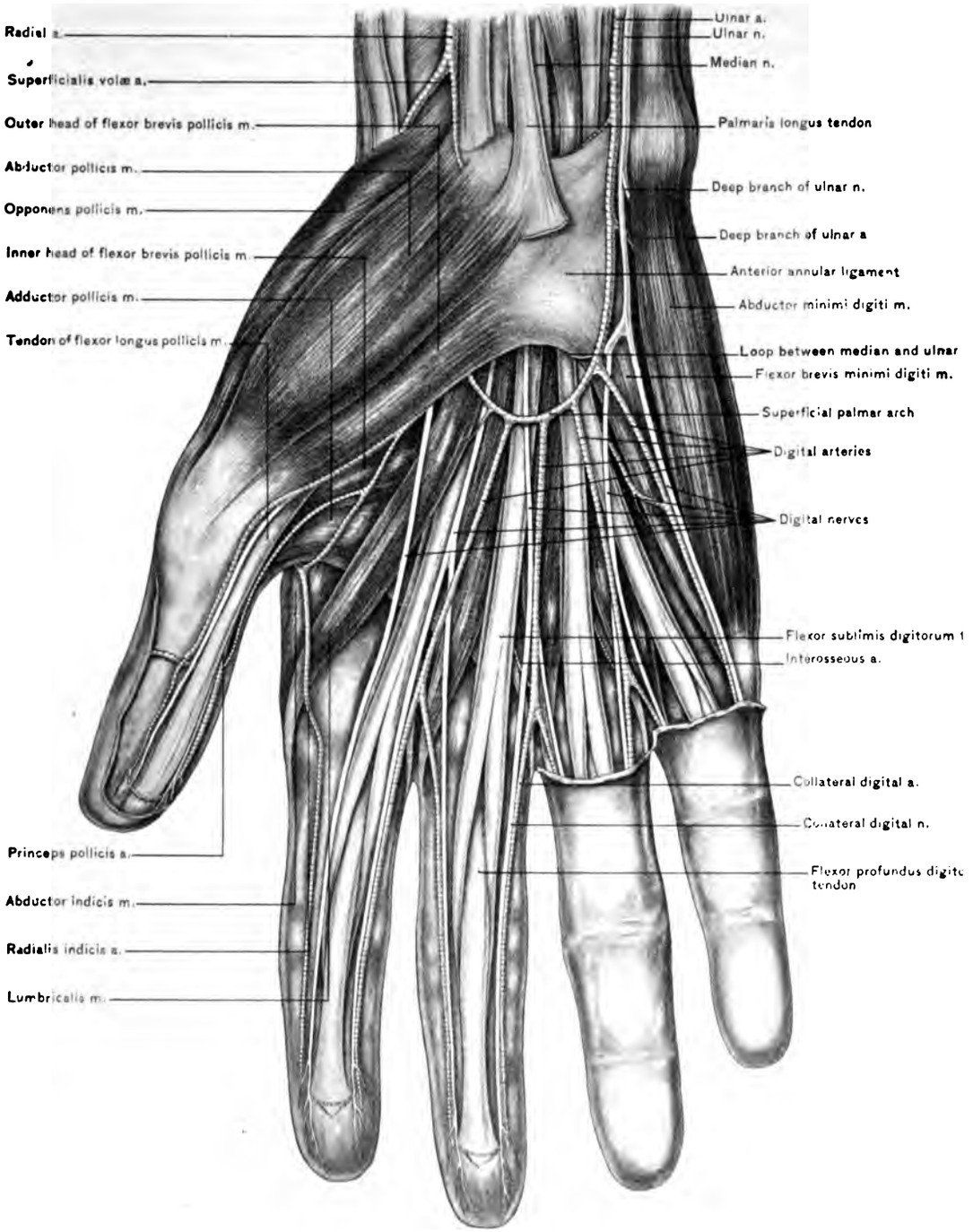
DISSECTION.—In removing the superficial palmar fascia begin at the wrist and work toward the digital clefts and dissect it free from the underlying deep palmar fascia. This exposes the *anterior annular ligament* of the wrist, a thickened band of the deep fascia of the forearm, which extends from the pisiform and the hook of the unciform bone, upon the ulnar side of the wrist, to the tuberosity of the scaphoid and the ridge of the trapezium upon the radial side of the wrist. It is firm, dense, and unyielding, gives origin to most of the muscles of the thenar and hypothenar eminences, and converts the hollow of the front of the wrist into a tunnel for the passage of some of the structures of the forearm which are destined for the front of the hand. It is crossed by the following structures, enumerated in their order, from the ulnar to the radial side: The tendon of the flexor carpi ulnaris, part of which it receives for insertion; the ulnar nerve, situated at the radial side of that tendon; the ulnar artery and its venæ comites; the palmar cutaneous branches of ulnar and median nerves; the palmaris longus, part of which it receives for insertion; and the tendon of the flexor carpi radialis, which passes over its upper margin and then pierces it. The tunnel beneath the ligament gives passage to the following structures: The tendons of the flexor sublimis digitorum and flexor profundus digitorum, the tendon of the flexor longus pollicis, and the median nerve.

The **great carpal or palmar bursa.**—In this tunnel there are two synovial sacs, separated by the median nerve; the outer invests the tendon of the flexor longus pollicis and extends upon the first phalanx of the thumb; the inner invests the tendons of the flexor sublimis digitorum and flexor profundus digitorum and extends to the middle of the palm. Upon the proximal two phalanges of the fingers the flexor tendons are also invested by a synovial sheath which lines their fibrous sheaths. The synovial sheath on the little finger is usually described as being continuous with the inner sac of the great carpal bursa, while the synovial sheaths on the tendons of the index, middle, and ring fingers cease at the heads of the metacarpal bones and do not communicate with the great carpal bursa. The arrangement of these sheaths probably differs somewhat in individuals. Schüller states that only exceptionally does the sheath for the little finger communicate with the main or inner synovial sac.

nerve, which they occasionally do, inflammation of one is readily communicated to the other. Purulent collections in the great carpal bursa require early and free incision, with, in some cases, division of the anterior annular ligament. Purulent collections in the sheaths of the flexor tendons of the index, middle, and ring fingers, by reason of the anatomic condition, would not extend into the palm further than the heads of the metacarpal bones.

The **deep palmar fascia** is intimately united to the skin in the middle of the palm, and less so at the sides. It is divided for description into a central and two lateral portions. The *central portion* is dense and strong, and protects the underlying vessels, nerves, and tendons from injury. Its strength is greatest in those who are accustomed to handling heavy implements. It is triangular in shape and narrow at its origin from the lower border of the anterior annular ligament, where it is strengthened by the broadened tendon of the palmaris longus. It expands in its passage through the palm to divide into four digital slips, one going to the base of each finger; not uncommonly an additional slip passes to the thumb. Each slip divides to permit the passage of the digital flexor tendons, the divisions being then inserted into the sides of the bases of the first phalanges and the deep transverse ligament which connects the heads of the metacarpal bones of the fingers. Each slip is also continuous with the fibrous sheath of the flexor tendons. At the point of division into its four digital processes, the fascia is strengthened by transverse fibers. Through the spaces between the primary divisions of the fascia pass the digital vessels and nerves and the lumbricales tendons. This central portion of the palmar fascia is closely united to the skin of the palm by many small, short, fibrous bands, which prevent the integumentary covering from being thrown into folds and from gliding to and fro during the various movements of the hand. From either side of the central portion a process of fascia dips into the palm to join the deep transverse layer of fascia which covers the interossei muscles, the deep palmar arch, and the metacarpal bones, thus separating the muscles of the thenar and hypothenar eminences from the center of the palm. This central fascial compartment contains the superficial palmar arch and its branches, the digital branches of the median nerve, the outer digital branch of the ulnar nerve, the superficial and deep flexor tendons, and the lumbrical muscles. This fascial compartment may be compared to a box the ends of which are open and correspond to the tunnel under

PLATE XL


Radial a.
Superficialis volæ a.
Outer head of flexor brevis pollicis m.
Abductor pollicis m.
Opponens pollicis m.
Inner head of flexor brevis pollicis m.
Adductor pollicis m.
Tendon of flexor longus pollicis m.
Princeps pollicis a.
Abductor indicis m.
Radialis indicis a.
Lumbricalis m.
Ulnar a.
Ulnar n.
Median n.
Palmaris longus tendon
Deep branch of ulnar n.
Deep branch of ulnar a
Anterior annular ligament
Abductor minimi digiti m.
Loop between median and ulnar
Flexor brevis minimi digiti m.
Superficial palmar arch
Digital arteries
Digital nerves
Flexor sublimis digitorum t
Interosseous a.
Collateral digital a.
Collateral digital n.
Flexor profundus digito
tendon

fascia offers some resistance to the passage of pus toward the dorsum of the hand. Contraction of the digital slip, passing to the ring or little finger, flexes the finger upon the palm at the metacarpo-phalangeal joint and produces the deformity known as Dupuytren's contraction of the finger. In these cases the fibrous band becomes prominent under the overlying skin, which often presents transverse folds over the contracted fascia. This condition can only be relieved by subcutaneous or open section of the offending slip.

The *lateral portions* of the palmar fascia are thin, and continuous with the central palmar fascia and the fascia of the dorsum of the hand; they cover the muscles of the thenar and hypothenar eminences.

DISSECTION.—Divide the expansion of the palmaris longus and reflect the central palmar fascia toward the fingers, noting its deep processes located upon either side. The structures of the palm now exposed are: The superficial palmar arch and its branches, the median nerve and its divisions, the superficial and deep flexor tendons, and the lumbrical muscles. Upon either side of the palm are the muscles composing the thenar and hypothenar eminences.

The **superficial palmar arch** is formed by the terminal part of the ulnar artery, and is completed by the superficialis volæ, or a branch from the radialis indicis or princeps pollicis, and sometimes, though rarely, by a large median artery. It commences at the lower border of the pisiform bone, where the ulnar artery gives off the deep or communicating branch which passes backward between the abductor minimi digiti and flexor brevis minimi digiti muscles to complete the deep palmar arch. It curves across the palm to the thenar eminence, where it is joined by the branch or branches which complete it. The convexity of the arch is directed toward the fingers, its lowest point corresponding to a line drawn transversely across the hand from the lower border of the strongly abducted thumb. The superficial palmar arch lies upon the short muscles of the little finger, the flexor tendons, and the digital branches of the median nerve, and is covered by the

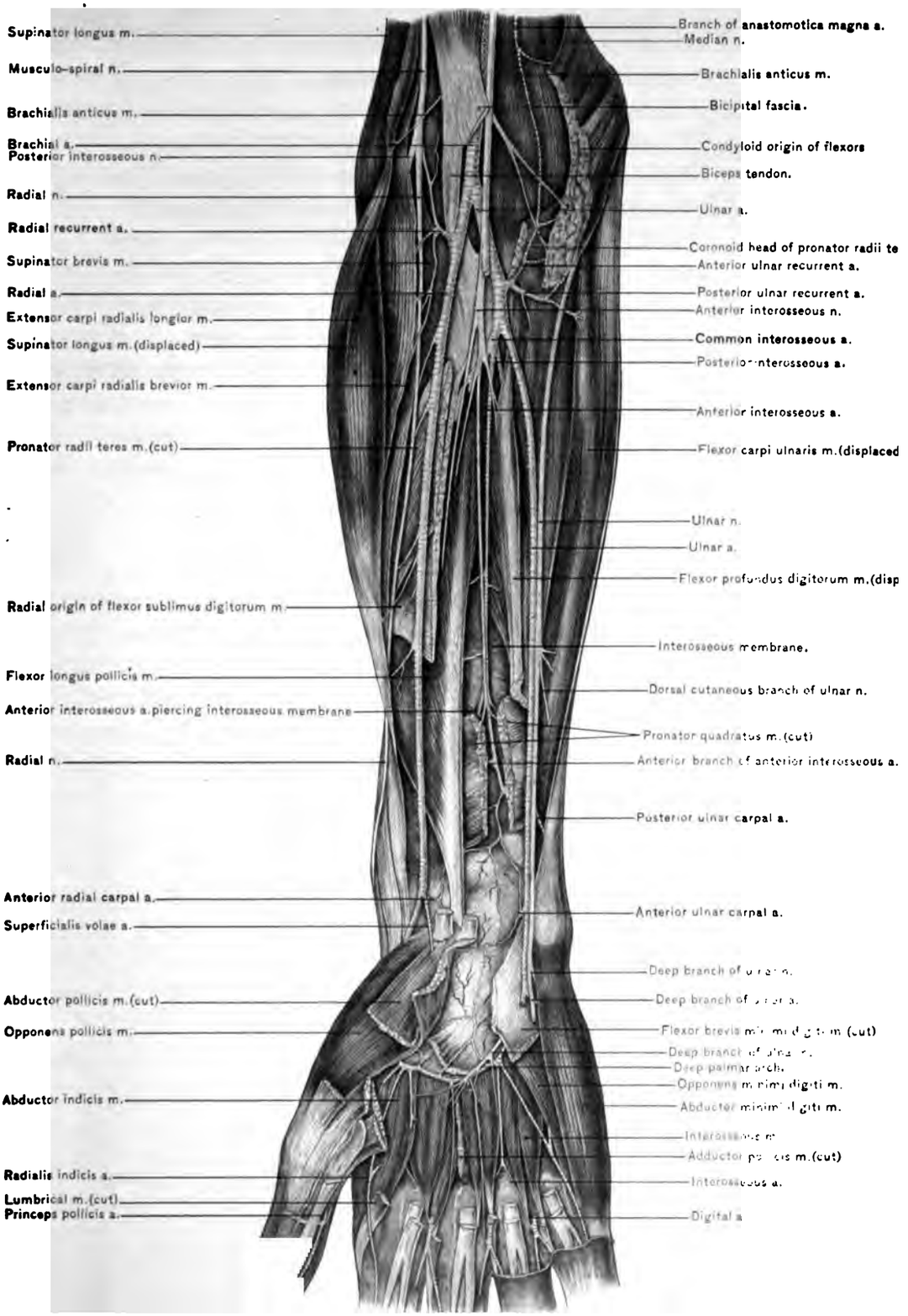
an inch above the clefts of the fingers, into two collateral digital branches for the supply of the adjacent sides of the fingers. At their commencement they lie over the superficial flexor tendons; but as they approach the clefts of the fingers, they course between them in company with the digital nerves, and also between the primary slips of the central palmar fascia with the nerves superficial to the arteries. As the digital arteries lie over the interosseous spaces, palmar abscesses should be opened in the line of the metacarpal bones. Upon the side of the finger the collateral digital artery is behind the nerve. The collateral digital arteries of each finger unite to form an arch across the front of the finger a little beyond the terminal joint, and from this arises an arterial plexus which supplies the pulp of the end of the finger and the matrix of the nail. Small twigs go to the interphalangeal joints, the integument and sheaths of the tendons, and form arterial plexuses, one being in front of each joint.

The **ulnar nerve** crosses the wrist in front of the anterior annular ligament upon the ulnar side of the ulnar artery, between the artery and the pisiform and unciform bones, where it rests in a groove between these bones protected thereby from pressure. It divides into a superficial and a deep branch. The superficial branch passes along the ulnar side of the palm, supplying the skin of this region and the palmaris brevis which covers it. It divides into a communicating and two digital branches. The inner digital branch supplies the inner side of the little finger; the outer divides into collateral digital branches to supply the adjacent sides of the little and ring fingers. The communicating branch joins the innermost digital branch of the median nerve. The deep branch of the ulnar nerve accompanies the profunda branch of the ulnar artery, and passes backward between the abductor and flexor brevis minimi digiti muscles, through the opponens minimi digiti, and upon the distal side of the deep palmar arch.

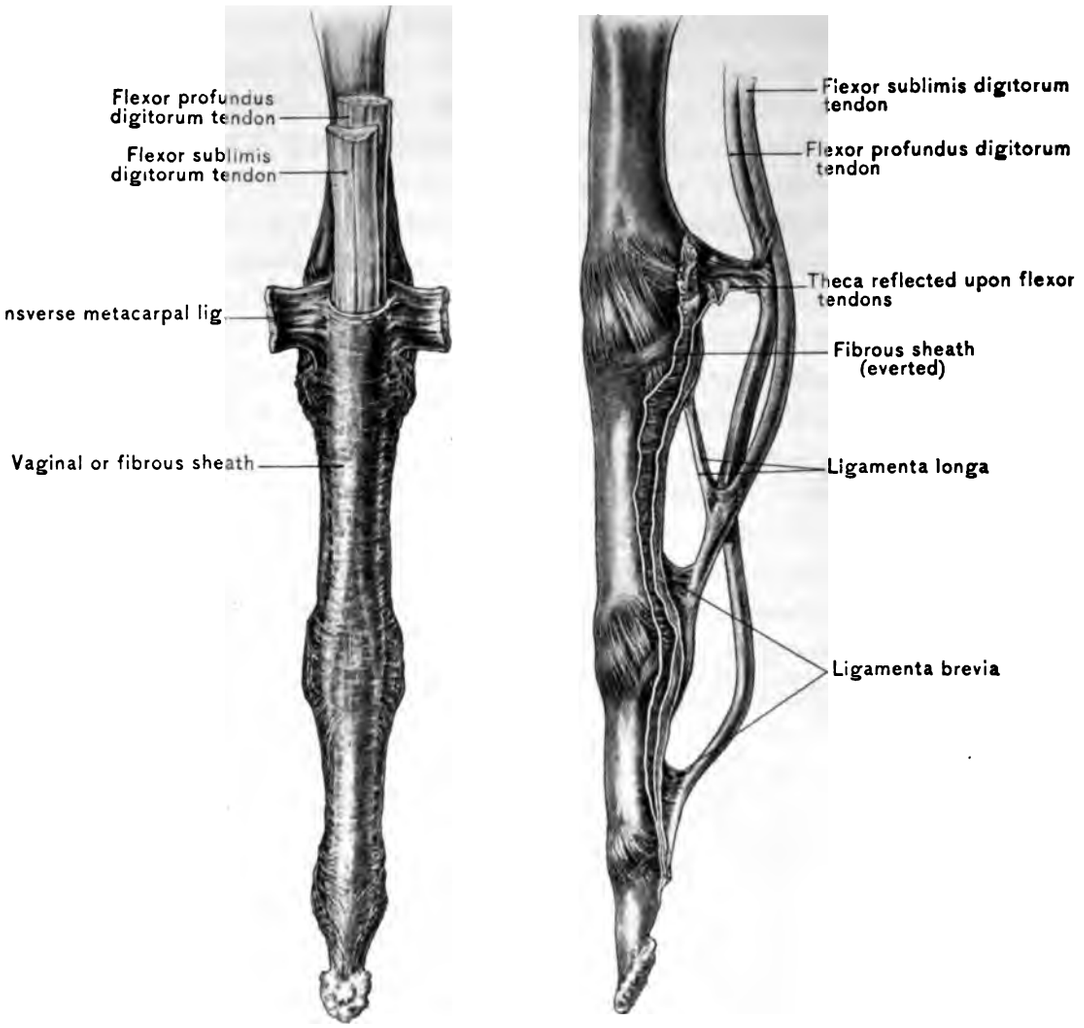
It supplies the short muscles of the little finger, all of the interossei, the two ulnar lumbricales, the adductor pollicis, and the inner or deep head of the flexor brevis pollicis.

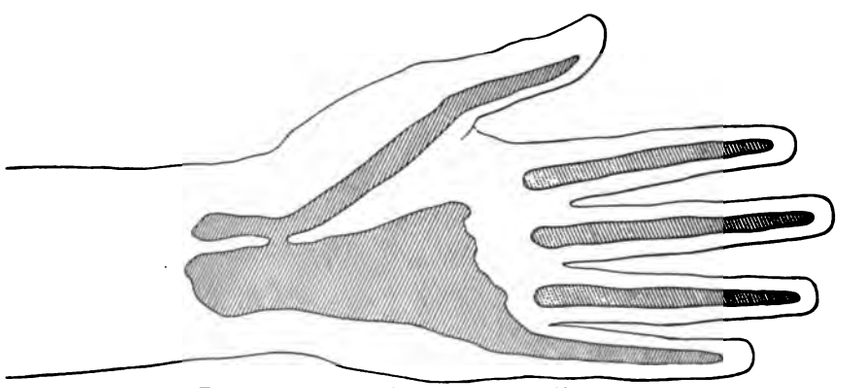
The **median nerve** enters the hand beneath the anterior annular ligament enveloped by the synovial sheaths of the flexor tendons of the hand; it rests upon the tendons, spreads out slightly, and bifurcates into an external and an internal division as it emerges from under the ligament.

The *external division* gives off muscular branches to the abductor and opponens pollicis, and outer head of the flexor brevis pollicis, after which it divides into two digital branches; the *outermost* supplies a collateral branch to either side of the thumb, while the *innermost* goes to the radial side of the index


Supinator longus m.
Musculo-spiral n.
Brachialis anticus m.
Brachial a.
Posterior interosseous n.
Radial n.
Radial recurrent a.
Supinator brevis m.
Radial a.
Extensor carpi radialis longior m.
Supinator longus m.(displaced)
Extensor carpi radialis brevior m.
Pronator radii teres m.(cut)
Radial origin of flexor sublimus digitorum m.
Flexor longus pollicis m.
Anterior interosseous a.piercing interosseous membrane
Radial n.
Anterior radial carpal a.
Superficialis volae a.
Abductor pollicis m.(cut)
Opponens pollicis m.
Abductor indicis m.
Radialis indicis a.
Lumbrical m.(cut)
Princeps pollicis a.
Branch of anastomotica magna a.
Median n.
Brachialis anticus m.
Bicipital fascia.
Condyloid origin of flexors
Biceps tendon.
Ulnar a.
Coronoid head of pronator radii te
Anterior ulnar recurrent a.
Posterior ulnar recurrent a.
Anterior interosseous n.
Common interosseous a.
Posterior interosseous a.
Anterior interosseous a.
Flexor carpi ulnaris m.(displaced
Ulnar n.
Ulnar a.
Flexor profundus digitorum m.(disp
Interosseous membrane.
Dorsal cutaneous branch of ulnar n.
Pronator quadratus m.(cut)
Anterior branch of anterior interosseous a.
Posterior ulnar carpal a.
Anterior ulnar carpal a.
Deep branch of ulnar n.
Deep branch of ulnar a.
Flexor brevis minimi digiti m.(cut)
Deep branch of ulnar n.
Deep palmar arch.
Opponens minimi digiti m.
Abductor minimi digiti m.
Interosseous m.
Adductor pollicis m.(cut)
Interosseous a.
Digital a.

ATE XLV.





Great carpal bursa and thecae.

an inner digital branch. The outer digital sends a branch to the second lumbrical muscle and divides into two collateral branches, which supply the adjacent sides of the index and middle fingers as well as the dorsum of these fingers. The inner digital, in addition to communicating with the ulnar nerve, divides into two collateral branches, which supply the adjacent sides of the middle and ring fingers, and also, occasionally, the third lumbrical muscle. Each collateral branch sends branches to the dorsum of the fingers, and that of the middle finger is almost entirely supplied by these nerves.

At first the digital nerves are beneath the superficial palmar arch and the digital branches arising therefrom, but they gradually become more superficial, and, along the sides of the fingers, lie in front of the collateral digital arteries. At the tips of the fingers they give off anterior twigs to supply the pulp of the finger, and on the posterior aspect, twigs which supply the matrix of the nail. Very careful dissection discovers, upon the finer ramifications of the collateral branches of the digital nerves, minute seed-like enlargements known as the Pacinian bodies—a form of nerve terminus.

The **flexor tendons** cross the wrist in a large compartment beneath the anterior annular ligament, the outermost being that for the *flexor longus pollicis*, which passes outward along the thumb. The four tendons of the *flexor sublimis digitorum* lie in the tunnel beneath the anterior annular ligament, arranged in two pairs, one being anterior to the other. The anterior pair go to the middle and ring fingers; the posterior, to the index and little fingers. Of the tendons of the *flexor profundus digitorum*, the outermost (for the index finger) is separated from the others; the remaining three are in close contact until after they enter the palm. Each flexor sublimis tendon is accompanied to the root of its respective finger by the corresponding deep flexor tendon which lies under it. The tendons of the deep flexor give origin to the lumbrical muscles. The flexor tendons are confined to the phalanges by fibrous sheaths, which must be laid open in order to expose the tendon.

The *fibrous sheaths* of the flexor tendons are subcutaneous. Upon either side of these sheaths are the collateral digital vessels and nerves. The sheaths are attached to the sharp lateral margins of the anterior surface of the phalanges, and thus form an osteo-fibrous canal, which is composed of bone behind and fibrous tissue in front. The sheaths are thin at the joints and thick opposite the body of the phalanges, and especially so opposite the middle of the proximal phalanges, at which point they are called the *vaginal ligament*. Throughout its entire length, each fibrous sheath is lined by a synovial membrane, which is

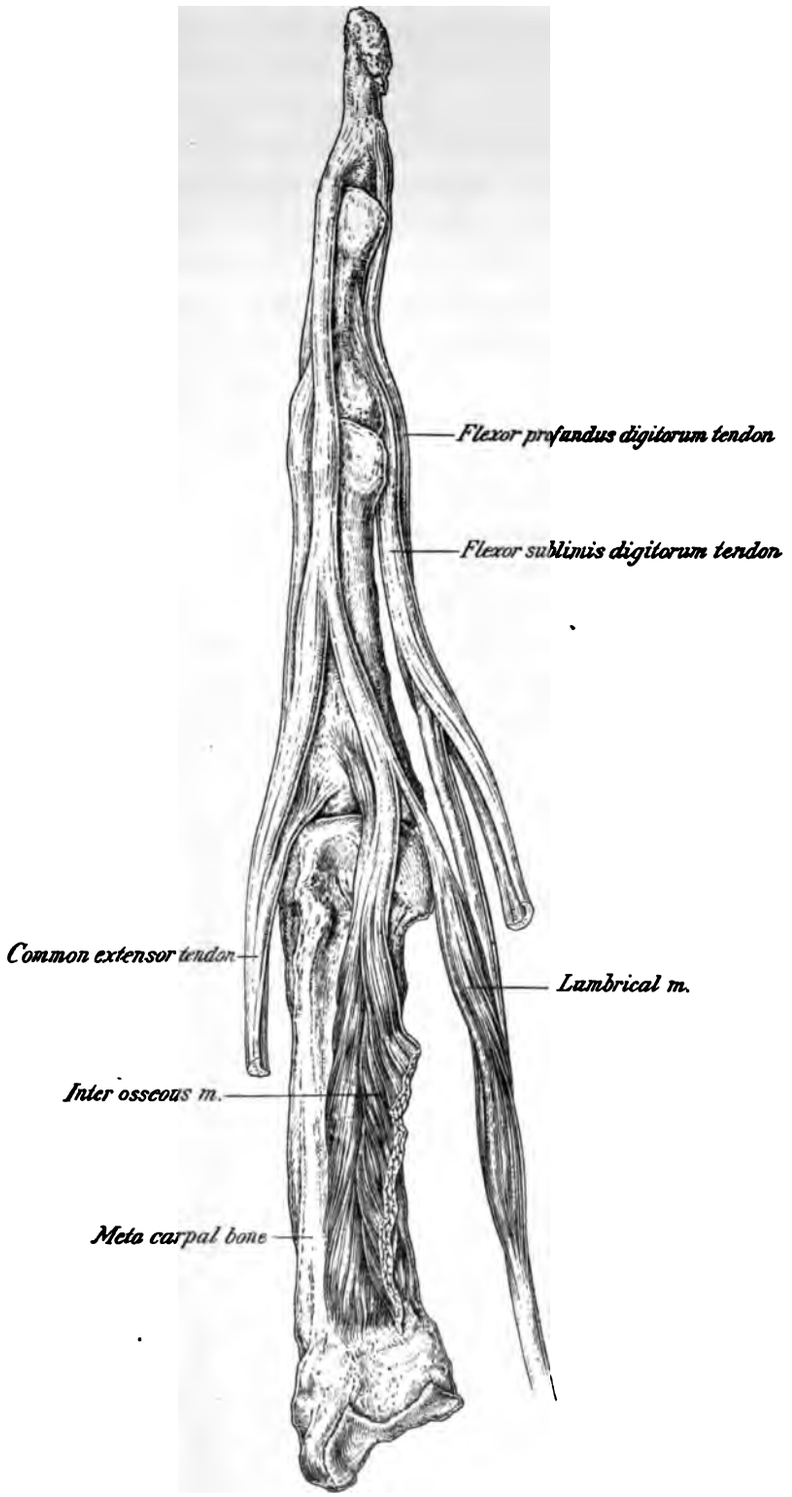
heads of the metacarpal bones to the middle of the distal phalanges, and do not communicate with the carpal bursæ, while those of the thumb and little finger do.

Upon the under surface of the flexor tendons, as they pass along the fingers, synovial reflections are found connecting them with the adjacent bone. These are triangular near the insertion of the tendon, and are called *ligamenta brevia:* longer and slender reflections, called *ligamenta longa*, make similar connections, but further from the insertion of the tendon, both being known collectively as the *vincula accessoria.* These vincula carry blood-vessels to the flexor tendons. Inflammation of the thecæ is known as thecitis. If the inflammation results in a purulent collection within the theca, it constitutes a superficial felon; while if the pus forms beneath the periosteal covering of the phalanx, a deep felon results. Superficial felons should be incised in the median line of the finger, so as to avoid the collateral digital arteries; while deep felons are preferably opened by an incision made along the side of the tendon.

The *insertions* of the flexor tendons are as follows: Each tendon of the flexor sublimis digitorum rests upon the corresponding tendon of the flexor profundus digitorum; opposite the metacarpo-phalangeal joints the tendons of the flexor sublimis broaden and, opposite the middle of the proximal phalanges, split into two segments, between which pass the tendons of the flexor profundus; they reunite and again divide, to be inserted into the middle of both sides of the second phalanges; the tendon of the flexor profundus, after perforating the tendons of the flexor sublimis, passes on for insertion into the front of the base of the last phalanx; the tendon of the flexor longus pollicis passes between the two heads of the flexor brevis pollicis for insertion into the front of the base of the last phalanx of the thumb.

The **lumbricales** are four slender, fleshy muscles which are accessory to the deep flexor tendons and connect these with the tendons of the extensor communis digitorum. They arise from the radial side of the deep flexor tendons of the index and middle fingers, and from the adjacent sides of the tendons of the middle, ring, and little fingers. Each muscle terminates in a delicate tendon, which passes

PLATE XL


Flexor profundus digitorum tendon
Flexor sublimis digitorum tendon
Common extensor tendon
Lumbrical m.
Inter osseous m.
Meta carpal bone

phalangeal joints and the extensor tendons in extending the two interphalangeal joints.

DISSECTION.—Remove the lateral portions of the deep palmar fascia and separate the muscles of the thenar and hypothenar eminences.

The **thenar eminence,** or ball of the thumb, is composed of four muscles, called the abductor pollicis, opponens pollicis, flexor brevis pollicis, and adductor pollicis.

The **abductor pollicis,** the most superficial muscle of the ball of the thumb, is a thin, flat muscle which arises from the front of the anterior annular ligament and the trapezium. It is inserted into the radial side of the base of the first phalanx of the thumb and the tendon of the extensor secundi internodii pollicis over the first phalanx. It rests upon the opponens pollicis and the superficial or outer head of the flexor brevis pollicis.

BLOOD SUPPLY.—From the superficialis volæ artery.

NERVE SUPPLY.—From the median nerve.

ACTION.—It abducts the thumb and assists in extension of the last phalanx.

DISSECTION.—Cut the muscle transversely at its middle, and reflect.

The **opponens pollicis** is small and triangular, and is subcutaneous in its outer part, while its inner portion is covered by the abductor pollicis. It arises, beneath the abductor, from the front of the anterior annular ligament and the trapezium, whence its fibers diverge for insertion into the radial side of the entire length of the metacarpal bone of the thumb. It is covered by the abductor pollicis and the deep fascia. It lies upon the joint between the trapezium and the metacarpal bone of the thumb and on the radial side of the superficial or outer head of the flexor brevis pollicis.

BLOOD SUPPLY.—From the radial and superficialis volæ arteries.

NERVE SUPPLY.—From the median nerve.

ACTION.—It draws the head of the metacarpal bone of the thumb toward the head of the metacarpal bone of the little finger, after which contraction of the long and short flexors brings the end of the thumb in contact with the base of the little finger.

The **flexor brevis pollicis** arises by a superficial and a deep head, between which passes the tendon of the flexor longus pollicis. The *superficial head* arises from the outer part of the anterior annular ligament and the trapezium; the *deep head* (by some described as a separate muscle, and called the oblique adductor of the thumb) arises from the bases of the first, second, and third metacarpal bones, from the trapezoid and os magnum, and the sheath of the tendon of the flexor

Each tendon of insertion contains a sesamoid bone where it passes over the meta-carpo-phalangeal joint; the tendon of the superficial or outer head is joined by the tendon of the abductor pollicis, and that of the deep or inner head by the tendon of the adductor pollicis. The superficial or outer head lies in contact with the ulnar border of the opponens pollicis, and is covered by the abductor pollicis and the deep fascia. It rests upon the opponens pollicis, the tendon of the flexor longus pollicis, and the inner or deep head. The superficial or outer head is covered by the deep fascia; the deep or inner head by the flexor tendons of the index and middle fingers and the outer two lumbricales. It rests upon the deep palmar arch, the muscles of the first two interosseous spaces, the tendon of the flexor carpi radialis, and the radialis indicis artery.

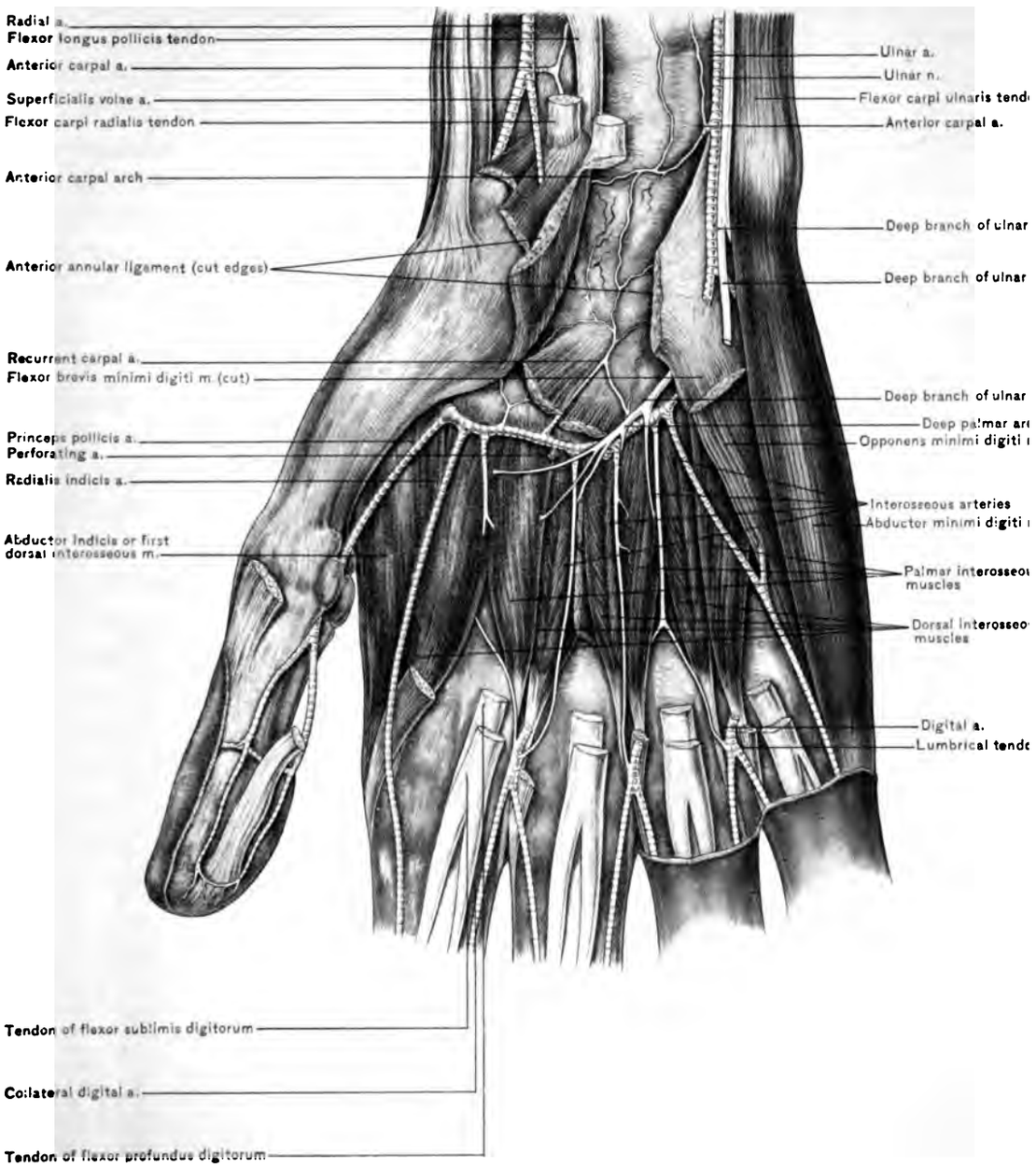
Blood Supply.—From the radial artery.

Nerve Supply.—From the median nerve, and the deep branch of the ulnar nerve. The median nerve supplies the superficial or outer head, the deep branch of the ulnar nerve the deep or inner head.

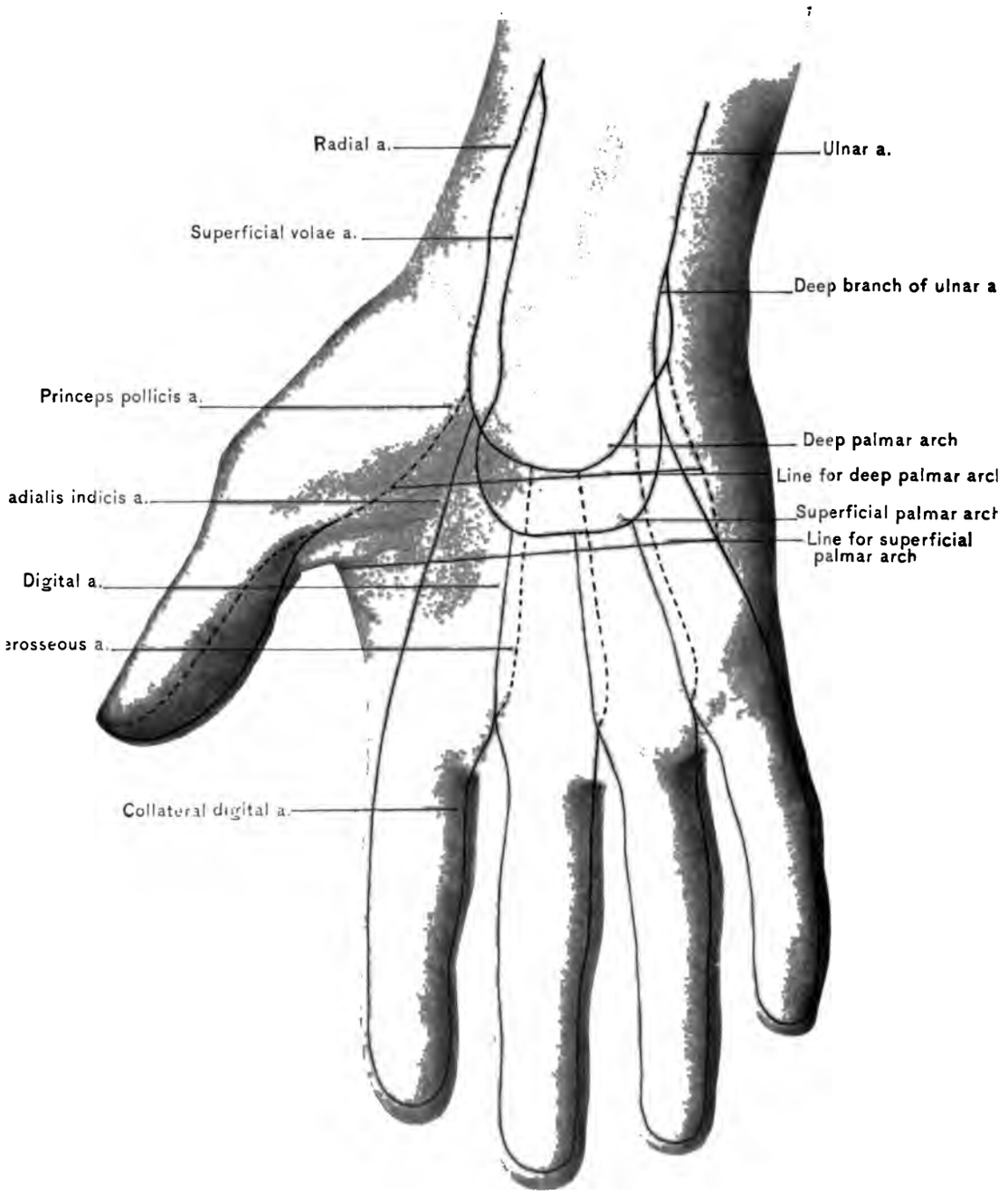
Action.—It flexes the carpo-metacarpal and metacarpo-phalangeal joints of the thumb. The deep or inner head is also an oblique adductor, aiding the contiguous adductor pollicis in drawing the head of the metacarpal bone of the thumb toward the pisiform bone.

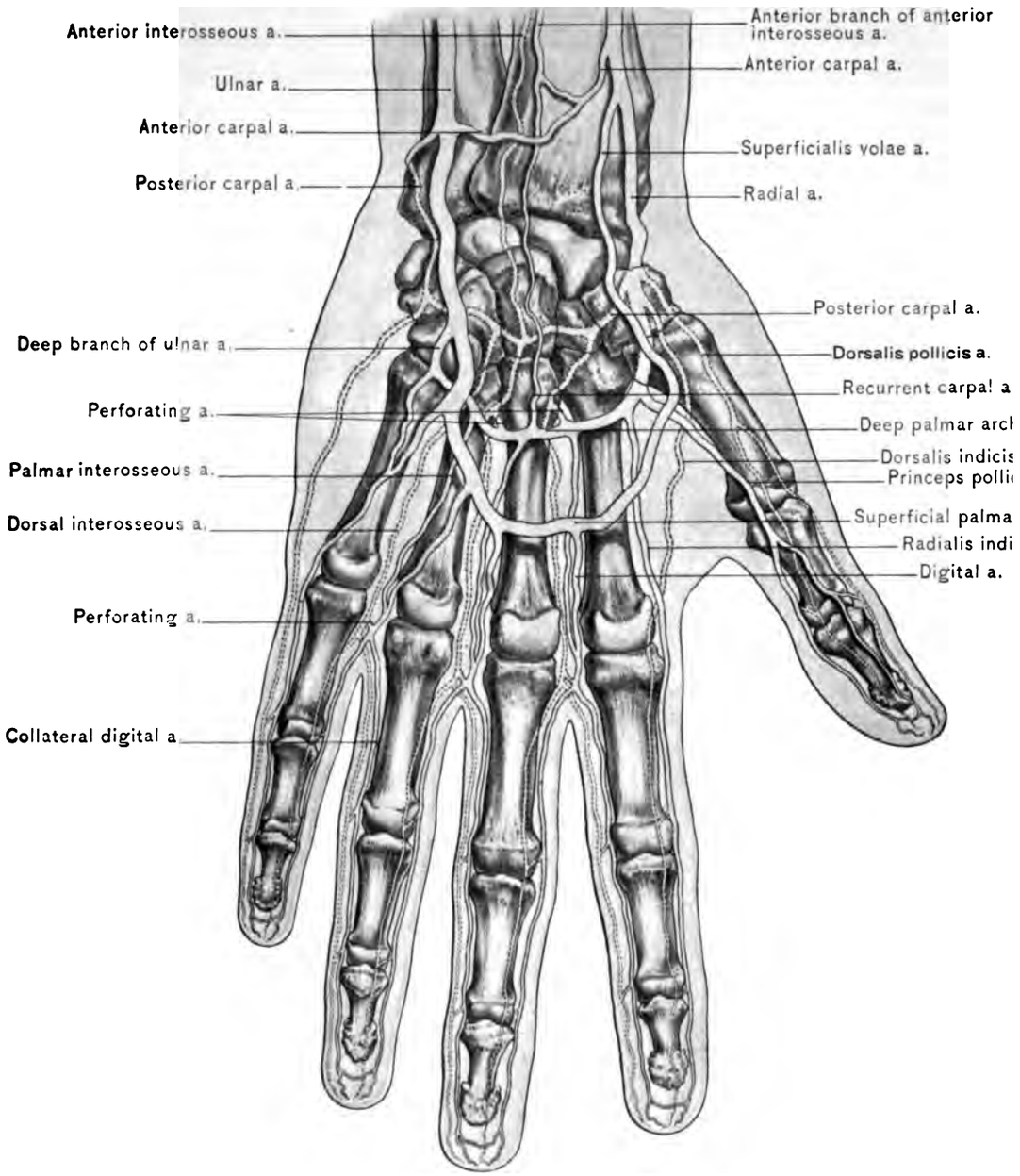
The **adductor pollicis** is the deepest muscle of this group, and is triangular in shape. It arises by its base from the front of the metacarpal bone of the middle finger, whence its fibers converge for insertion into the ulnar side of the base of the first phalanx of the thumb, in common with the inner tendon of the flexor brevis pollicis. It is covered by the ulnar border of the deep or inner head of the flexor brevis pollicis, the outer two tendons of the flexor sublimis and flexor profundus digitorum muscles, and the two outer lumbricales. It lies upon the radialis indicis artery, the abductor indicis muscle, and the interosseous muscles

PLATE XL


Radial a.
Flexor longus pollicis tendon
Anterior carpal a.
Superficialis volae a.
Flexor carpi radialis tendon
Anterior carpal arch
Anterior annular ligament (cut edges)
Recurrent carpal a.
Flexor brevis minimi digiti m. (cut)
Princeps pollicis a.
Perforating a.
Radialis indicis a.
Abductor indicis or first dorsal interosseous m.
Tendon of flexor sublimis digitorum
Collateral digital a.
Tendon of flexor profundus digitorum
Ulnar a.
Ulnar n.
Flexor carpi ulnaris tend
Anterior carpal a.
Deep branch of ulnar
Deep branch of ulnar
Deep branch of ulnar
Deep palmar ar
Opponens minimi digiti
Interosseous arteries
Abductor minimi digiti
Palmar interosseou muscles
Dorsal interosseo muscles
Digital a.
Lumbrical tend

E XLVIII.


Radial a.
Ulnar a.
Superficial volae a.
Deep branch of ulnar a
Princeps pollicis a.
Deep palmar arch
adialis indicis a.
Line for deep palmar arch
Superficial palmar arch
Line for superficial palmar arch
Digital a.
erosseous a.
Collateral digital a.


Anterior interosseous a.
Ulnar a.
Anterior carpal a.
Posterior carpal a.
Deep branch of ulnar a.
Perforating a.
Palmar interosseous a.
Dorsal interosseous a.
Perforating a.
Collateral digital a
Anterior branch of anterior interosseous a.
Anterior carpal a.
Superficialis volae a.
Radial a.
Posterior carpal a.
Dorsalis pollicis a.
Recurrent carpal a
Deep palmar arch
Dorsalis indicis
Princeps pollicis
Superficial palma
Radialis indi
Digital a.

base of the first phalanx of the little finger and into the same side of the tendon of the extensor minimi digiti. It is subcutaneous, except at its base, where it is covered by the palmaris brevis. It rests upon the opponens minimi digiti on the ulnar side of the flexor brevis minimi digiti.

BLOOD SUPPLY.—From the ulnar artery.

NERVE SUPPLY.—From the deep branch of the ulnar nerve.

ACTION.—It abducts the little finger, flexes the metacarpo-phalangeal articulation, and extends the interphalangeal joints of that finger.

The **flexor brevis minimi digiti** lies upon the radial side of the preceding muscle and arises from the anterior annular ligament and the hook of the unciform bone. It is inserted, with the preceding muscle, into the ulnar side of the base of the proximal phalanx of the little finger. It is subcutaneous, except where it is covered by the palmaris brevis. It rests upon the opponens minimi digiti.

BLOOD SUPPLY.—From the ulnar artery.

NERVE SUPPLY.—From the deep branch of the ulnar nerve.

ACTION.—It flexes the metacarpo-phalangeal joint of the little finger.

The **opponens minimi digiti** (also called flexor ossis metacarpi minimi digiti), is triangular in form and corresponds to the opponens pollicis. It arises at its apex from the anterior annular ligament and the hook of the unciform bone, whence its fibers diverge for insertion into the entire length of the ulnar margin of the metacarpal bone of the little finger. It is covered by the two preceding muscles, and rests upon the interosseous muscles of the fourth interspace, the metacarpal bone, and the deep branches of the ulnar artery and nerve.

BLOOD SUPPLY.—From the ulnar artery.

NERVE SUPPLY.—From the deep branch of the ulnar nerve.

ACTION.—It draws the head of the metacarpal bone of the little finger forward and toward the radial side of the hand, aiding in hollowing the palm and in approximating the little finger to the thumb.

DISSECTION.—Divide the anterior annular ligament and the flexor tendons; reflect the latter, with the lumbrical muscles, downward, when the deep transverse layer of fascia which covers the deep palmar arch, the deep branch of the ulnar nerve, the interossei muscles, and the metacarpal bones will be exposed. Remove the deep transverse layer of fascia and trace the vessels and nerve beneath it. Next, sever the adductor pollicis and inner or deep head of the flexor brevis

at the entrance of the radial artery into the palm, between the two heads of the first dorsal interosseous (abductor indicis) muscle. It then passes between the adductor pollicis and the inner head of the flexor brevis pollicis, whence it arches, convexity downward, over the bases of the metacarpal bones and the palmar interosseous muscles to the base of the metacarpal bone of the little finger, where it is completed by joining the deep branch of the ulnar artery. It is less curved than the superficial arch and is situated one-half of an inch nearer the wrist. It is accompanied by the deep branch of the ulnar nerve.

The *branches* of the deep palmar arch are, from its convexity, the princeps pollicis, the radialis indicis, the palmar interosseous, and the superior perforating, and, from the concavity of the arch, the recurrent carpal arteries.

The **princeps pollicis artery** arises separately or by a common trunk with the radialis indicis from the arch, close to the interval between the two heads of the first dorsal interosseous muscle. It first passes between the first dorsal interosseous muscle and the flexor brevis pollicis, then between the two heads of the latter along the metacarpal bone of the thumb, under cover of the tendon of the flexor longus pollicis, to the base of the first phalanx, where it divides into two collateral branches which descend upon the sides of the thumb, with the tendon of the flexor longus pollicis between them. They terminate in an arch similar to that formed by the collateral arteries of the fingers.

The **radialis indicis artery** is given off near the preceding artery. It passes between the first dorsal interosseous muscle (abductor indicis) and the adductor pollicis along the palmar aspect of the radial border of the index finger.

The **palmar interosseous arteries,** three in number, pass downward over the interosseous muscles in the second, third, and fourth interosseous spaces, to join the corresponding digital branches of the superficial palmar arch just before they divide into the collateral digital arteries.

The **superior perforating arteries,** three in number, pierce the upper ends of the inner three interosseous spaces, and pass between the heads of the dorsal interosseous muscles to join the dorsal interosseous arteries.

The **recurrent carpal arteries,** two or three in number, pass upward, in front of the wrist, to join branches of the anterior carpal arch and the anterior branch of the anterior interosseous artery.

When one of the palmar arches is wounded, control the hemorrhage by making pressure upon the radial and ulnar arteries, and cleanse the wound. The

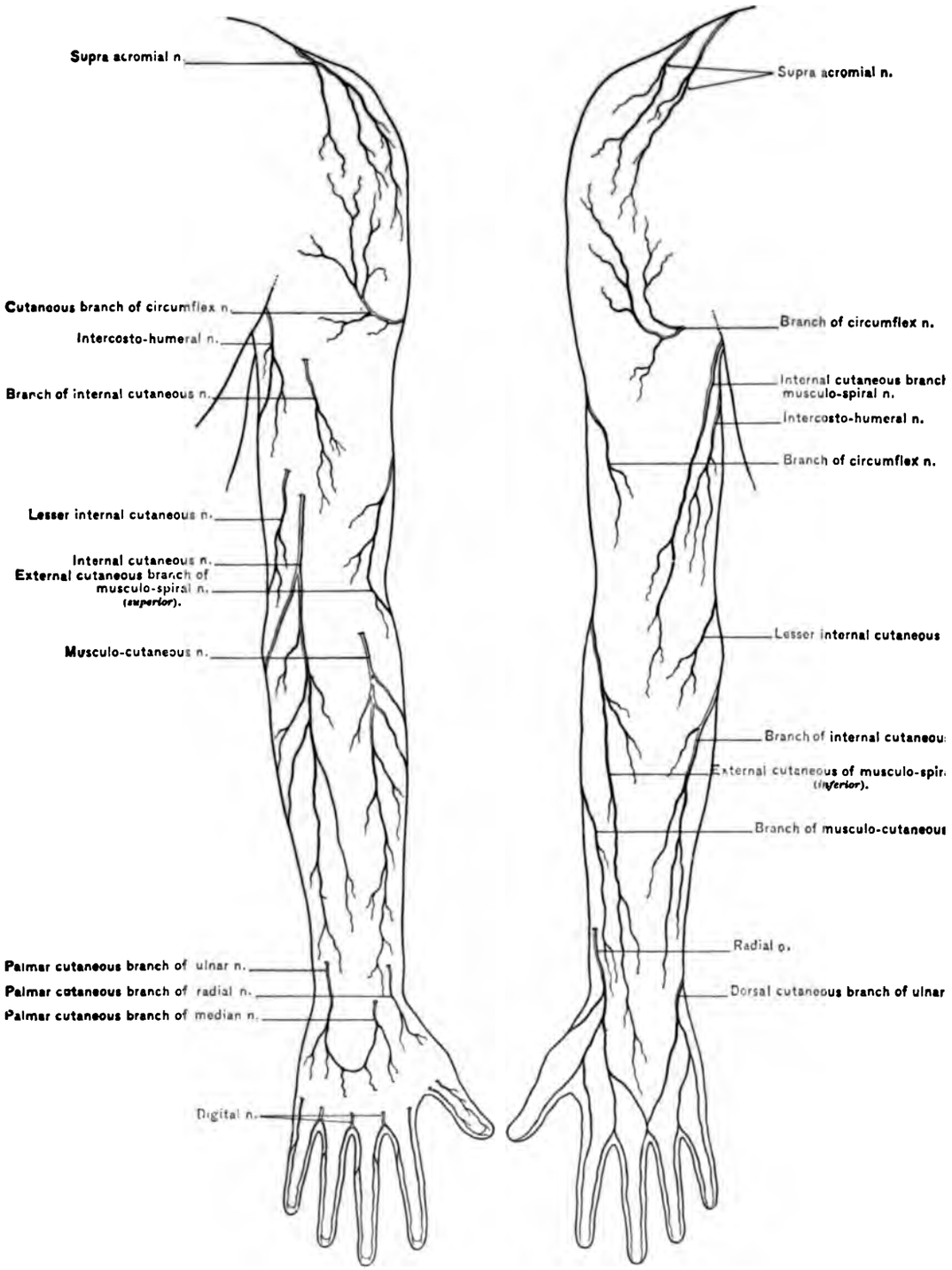
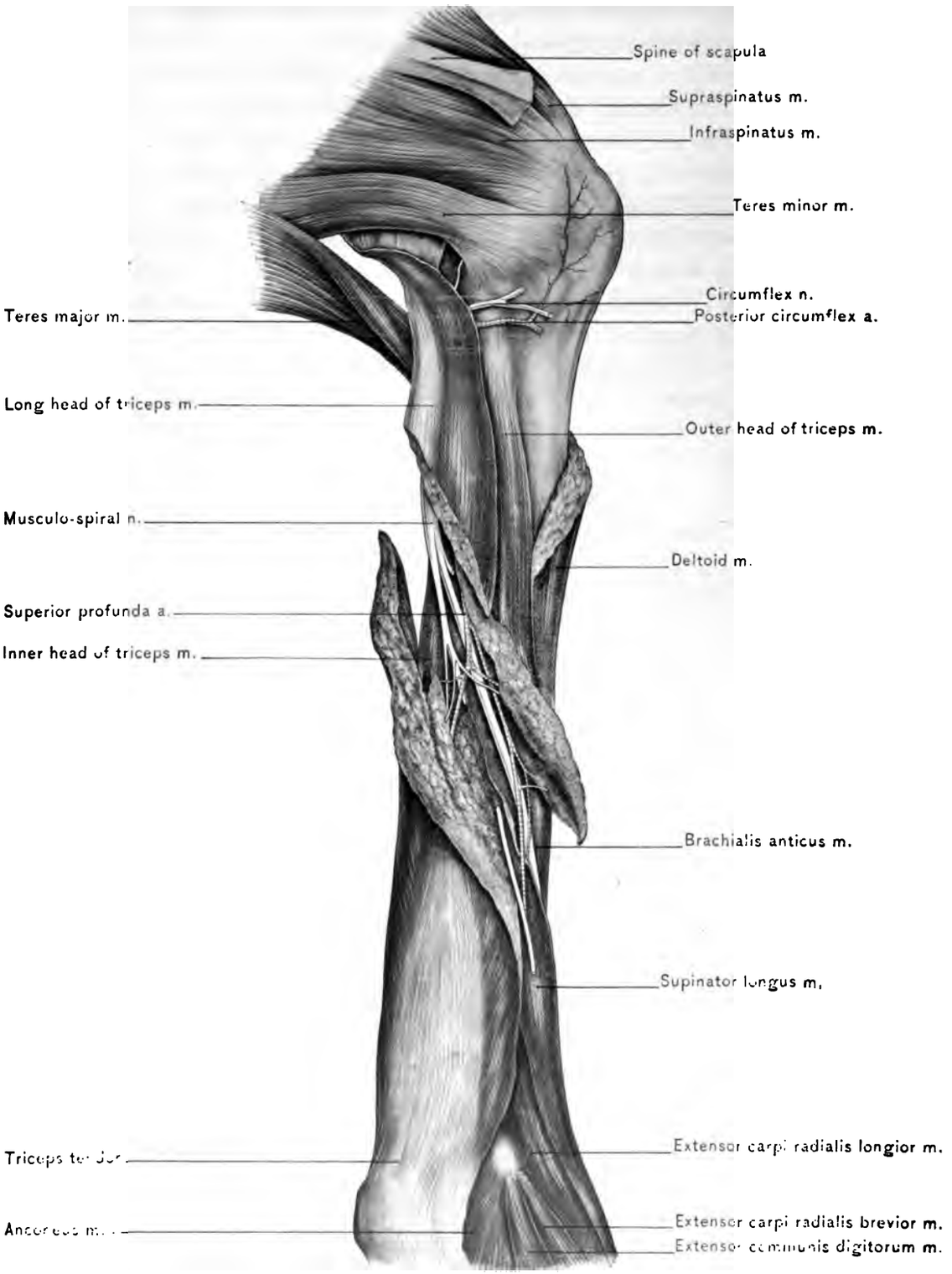
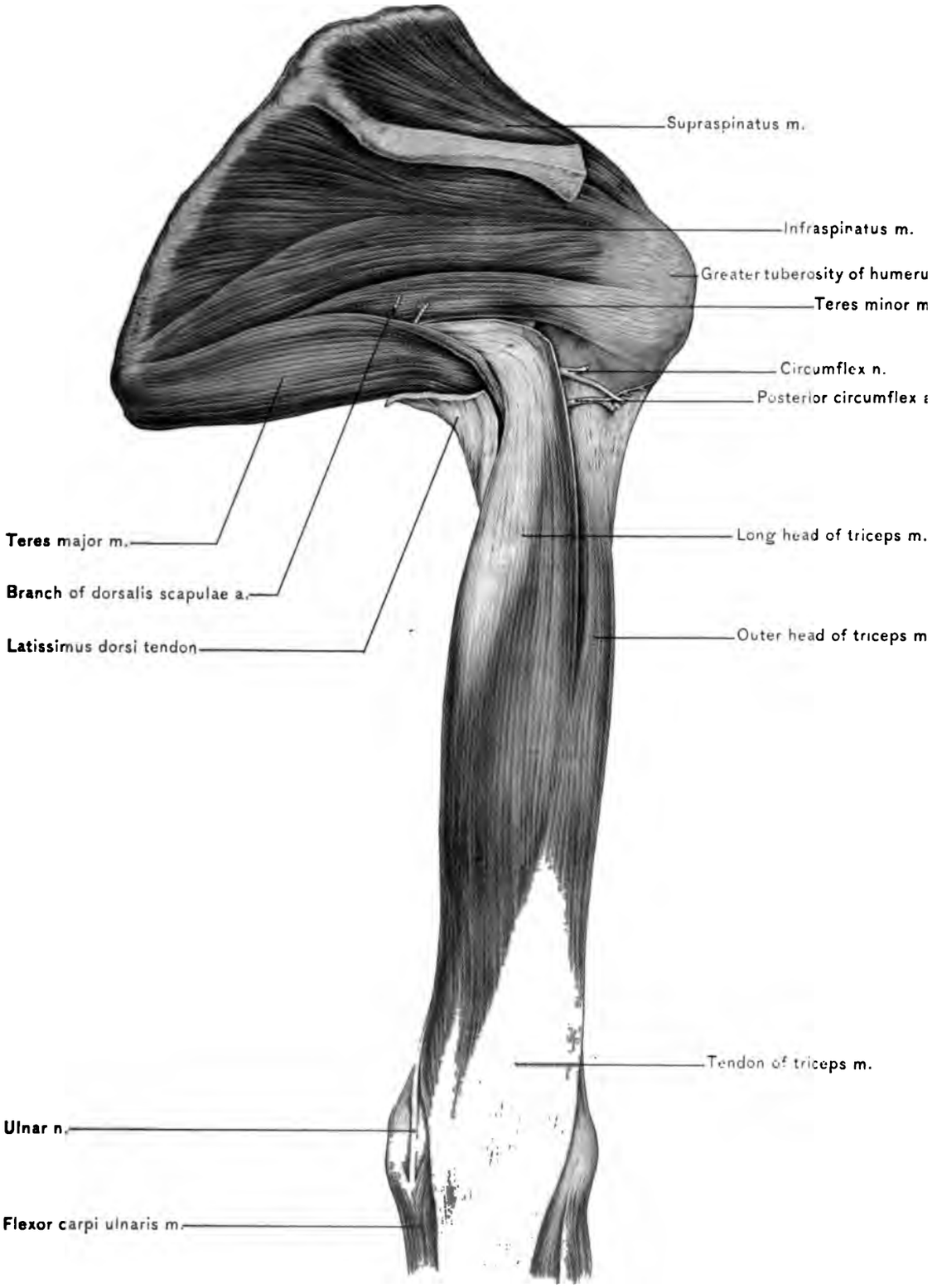

Supra acromial n.
Cutaneous branch of circumflex n.
Intercosto-humeral n.
Branch of internal cutaneous n.
Lesser internal cutaneous n.
Internal cutaneous n.
External cutaneous branch of musculo-spiral n. (superior).
Musculo-cutaneous n.
Palmar cutaneous branch of ulnar n.
Palmar cutaneous branch of radial n.
Palmar cutaneous branch of median n.
Digital n.
Supra acromial n.
Branch of circumflex n.
Internal cutaneous branch musculo-spiral n.
Intercosto-humeral n.
Branch of circumflex n.
Lesser internal cutaneous
Branch of internal cutaneou
External cutaneous of musculo-spir (inferior).
Branch of musculo-cutaneous
Radial n.
Dorsal cutaneous branch of ulnar

PLATE LI.


Spine of scapula
Supraspinatus m.
Infraspinatus m.
Teres minor m.
Circumflex n.
Teres major m.
Posterior circumflex a.
Long head of triceps m.
Outer head of triceps m.
Musculo-spiral n.
Deltoid m.
Superior profunda a.
Inner head of triceps m.
Brachialis anticus m.
Supinator longus m.
Extensor carpi radialis longior m.
Extensor carpi radialis brevior m.
Extensor communis digitorum m.

PLATE


Supraspinatus m.
Infraspinatus m.
Greater tuberosity of humeru
Teres minor m
Circumflex n.
Posterior circumflex a
Teres major m.
Long head of triceps m.
Branch of dorsalis scapulae a.
Latissimus dorsi tendon
Outer head of triceps m
Tendon of triceps m.
Ulnar n.
Flexor carpi ulnaris m.

irritation may develop an epithelioma. If ligature of the bleeding ends be not possible, use a graduated compress. This may be made by placing a small piece of dry antiseptic gauze or lint upon the bleeding points in the bottom of the wound and then adding successively larger sections of dry gauze or lint. The metacarpal bones supply the requisite counterpressure. The compress is covered with aseptic cotton and a bandage applied. The amount of pressure required is very small. The dressing is removed after twelve hours. If this method does not succeed, forcipressure may be used—hemostatic forceps are allowed to remain attached to the bleeding arteries. Flexion of the elbow and wrist should also be practised in conjunction with the compress and forcipressure. If these means fail, the brachial should be tied above the bend of the elbow. If the radial and ulnar are ligatured, hemorrhage from a wounded superficial palmar arch may still occur through a large *median artery;* and, from a wounded deep palmar arch, through a large *anterior interosseous artery.* Both of these possibilities are eliminated by ligature of the brachial artery.

The **palmar interossei** are three slender muscles, the first of which arises from the ulnar side of the metacarpal bone of the index finger and is inserted into the base of the first phalanx and the extensor tendon of the same finger; the *second* from the radial side of the metacarpal bone of the ring finger, and is inserted into the base of the first phalanx and the extensor tendon upon the same side of this finger; the third has a similar origin, and insertion upon the radial side of the little finger.

Blood Supply.—These muscles are nourished by the deep palmar arch.

Nerve Supply.—From the deep branch of the ulnar nerve.

Action.—They adduct the fingers to which they are attached, flex the respective metacarpo-phalangeal joints, and extend the last two phalanges. By adduction of the fingers is meant drawing them toward the median line of the middle finger, while abduction is drawing the fingers away from that line.

THE BACK OF THE ARM.

DISSECTION.—With the body lying face downward, abduct the arm to a right angle with the trunk. If the body lie upon its back, flex the forearm upon the arm and adduct the arm across the upper part of the chest so that the elbow will be opposite the neck. Fix the arm in this position by means of hooks. Continue the transverse incision, made on the upper part of the front of the forearm, around the back of the forearm, and reflect the skin toward the shoulder. In removing the superficial fascia, which is best done from without inward, trace the superficial nerves when reflecting the fascia. The nerves which supply the skin and superficial fascia of the back of the arm are, from without inward, the inferior external cutaneous branch of the musculo-spiral, the terminal portion of the lower branch of the circumflex, the intercosto-humeral, the lesser internal cutaneous, and the internal cutaneous of the musculo-spiral.

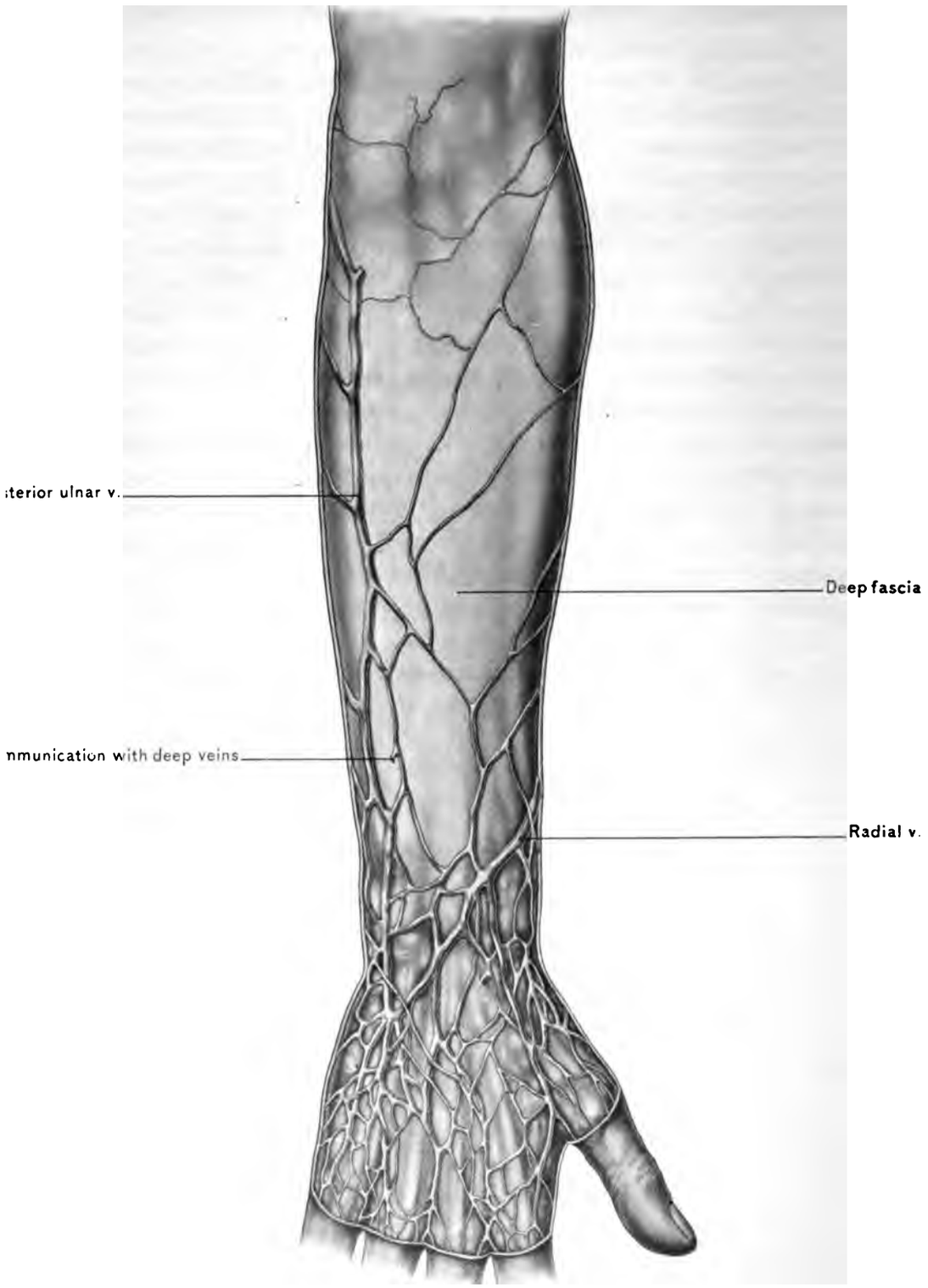
Before dissecting out the superficial nerves, note the bursa found over the olecranon. It is generally of considerable size, and may be very prominent if distended, constituting what is known as "miner's elbow." Other bursæ may sometimes be found over the internal and external condyles of the humerus, and, lower down, upon the ulna and over its styloid process.

The **inferior external cutaneous branch** of the musculo-spiral nerve becomes superficial upon the outer side of the arm below the insertion of the deltoid, and then passes backward and downward behind the outer humeral condyle to the forearm. The terminal portion of the lower branch of the circumflex nerve pierces the deep fascia, and supplies the skin over the lower part of the posterior surface of the deltoid muscle and the long head of the triceps.

The **internal cutaneous branch** of the musculo-spiral nerve emerges from the axilla at the outer end of the posterior fold, and passes downward along the inner and back part of the arm toward the elbow.

The **intercosto-humeral nerve** passes down the arm, upon the inner side of

PLATE LIII.


terior ulnar v.
Deep fascia
nmunication with deep veins
Radial v.

bone is divided into two portions, by the musculo-spiral groove which passes obliquely downward and from within outward. The portion of the muscle which arises from the scapula is called the *long head*, and that from above and external to the musculo-spiral groove of the humerus, the *external head;* while that below and internal to the groove, the *internal head.*

The **long, middle, or scapular head** arises by a flat tendon from a triangular depression on the axillary border of the scapula, immediately below the glenoid cavity; it blends with the glenoid and capsular ligaments, the long head of the biceps being similarly attached at the upper margin of the same cavity.

The **external head** arises from the posterior surface of the shaft of the humerus, above and external to the musculo-spiral groove, and from the external intermuscular septum to the point where it is pierced by the musculo-spiral nerve. The surface of origin extends as high as the insertion of the teres minor.

The **inner or short head** arises from the back of the shaft of the humerus below and internal to the musculo-spiral groove, the internal intermuscular septum and the external intermuscular septum below the point where it is pierced by the musculo-spiral nerve. The surface of origin extends upward as far as the insertion of the teres major into the posterior bicipital ridge and downward to within one-half of an inch of the upper edge of the olecranon fossa.

Tendon of insertion.—The long head becomes tendinous in the lower third of the arm where it is joined on the outer side by the external head. The greater part of the internal head is attached to the under surface and either side of this tendon. The deeper fibers of the internal head are inserted directly into the olecranon and posterior ligament of the elbow-joint. The common tendon, which is inserted into the summit and sides of the olecranon, is continuous with the deep fascia of the forearm upon either side.

The long head of the triceps, in its descent from the scapula, passes between the teres minor behind and the teres major in front, and assists in forming a quadrangle which is bounded by the humerus externally, the teres minor above, the long head of the triceps internally, and the teres major below; a triangle is found

BLOOD SUPPLY.—The nutriment of the triceps is derived from the superior and inferior profunda, the anastomotica magna, and muscular branches of the brachial artery.

NERVE SUPPLY.—From the musculo-spiral nerve.

ACTION.—It extends the forearm and adducts the humerus. The long head, by preventing downward luxation of the head of the humerus, forms a protection to the shoulder-joint.

The **subanconeus** is a very small muscle bearing the same relation to the triceps muscle and the elbow-joint that the subcrureus does to the crureus muscle and the knee-joint. It consists of those fibers of the internal head of the triceps which are inserted into the posterior ligament of the elbow-joint.

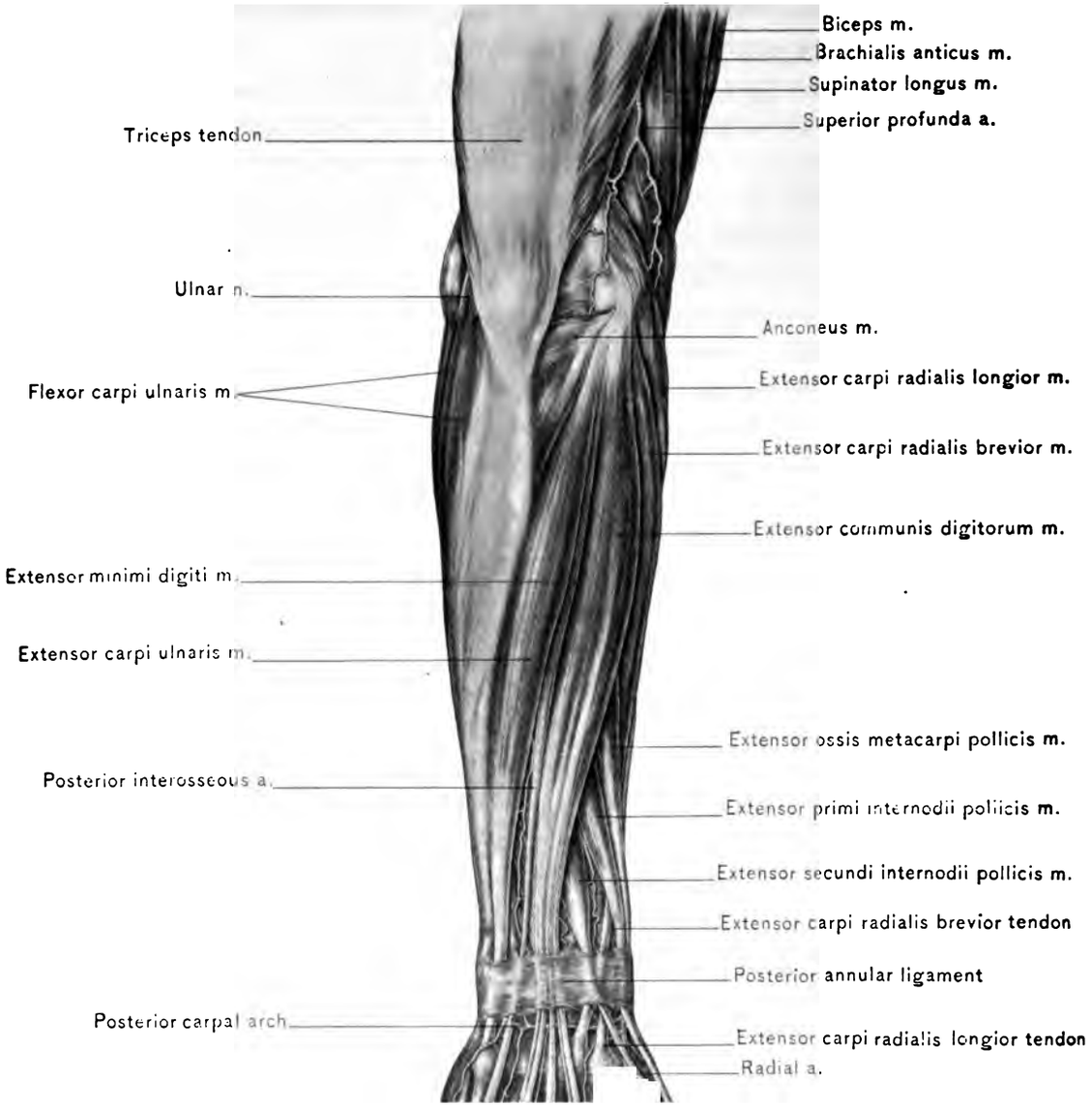
NERVE SUPPLY.—The same as that of the triceps.

ACTION.—It draws the posterior ligament upward during the relaxation accompanying extension of the elbow and prevents pinching of the synovial membrane.

The **musculo-spiral nerve** is best observed on the back of the arm, after division of the long and external heads of the triceps muscle over the musculo-spiral groove, when the branches given off to the triceps can be traced. From the branch to the internal head a small nerve, accompanied by the posterior articular branch from the superior profunda artery, may be seen passing downward under cover of the outer edge of the tendon, from beneath which it emerges between the olecranon and external condyle of the humerus to enter and supply the anconeus muscle. Owing to its proximity to the bone, the musculo-spiral nerve may be injured in fractures, or become involved in the resulting callus.

The **superior profunda artery,** lying in the groove with the musculo-spiral nerve, is exposed by the same dissection. As it emerges from under the outer edge of the triceps it sends off a large superficial branch (posterior articular) to the elbow, after which it divides into two branches, one passing between the triceps

PLATE LIV.


Biceps m.
Brachialis anticus m.
Supinator longus m.
Superior profunda a.
Triceps tendon
Ulnar n.
Anconeus m.
Flexor carpi ulnaris m.
Extensor carpi radialis longior m.
Extensor carpi radialis brevior m.
Extensor communis digitorum m.
Extensor minimi digiti m.
Extensor carpi ulnaris m.
Extensor ossis metacarpi pollicis m.
Posterior interosseous a.
Extensor primi internodii pollicis m.
Extensor secundi internodii pollicis m.
Extensor carpi radialis brevior tendon
Posterior annular ligament
Posterior carpal arch
Extensor carpi radialis longior tendon
Radial a.

THE BACK OF THE FOREARM.

DISSECTION.—Reflect the skin from the back of the forearm and hand as far as the roots of the fingers, and sever it at this point. Next incise the skin of the fingers in the median line and reflect it laterally. By reflecting the skin of the dorsum of the hand and fingers at the same time, a better opportunity is given for studying the superficial structures. The superficial fascia is now exposed. It contains the superficial veins, lymphatics, and nerves.

The **veins** of the back of the hand and forearm should be dissected out before removing the superficial fascia. These veins are the radial and the anterior and the posterior ulnar. The radial and anterior ulnar pass to the front of the forearm just above the wrist, while the posterior ulnar continues on the back of the forearm almost as far as the elbow. These veins commence on the back of the hand in a plexus which receives the veins of the fingers. The radial vein arises from the outer side of the plexus, while the anterior and posterior ulnar arise from the inner side of the plexus. The veins of the fingers commence in a plexus situated around the matrix of the nail.

The **lymphatics** on the back of the fingers terminate in a plexus on the back of the hand, from which vessels pass up the back of the forearm and around the radial and ulnar borders to join those on the anterior surface.

DISSECTION.—Reflect the superficial fascia and trace the nerves. The superficial nerves seen upon the back of the forearm and hand are the musculo-cutaneous, the inferior external cutaneous branch of the musculo-spiral, the lesser internal cutaneous, the internal cutaneous, radial, and ulnar nerves.

The **posterior branch** of the musculo-cutaneous nerve passes to the back of the forearm over the prominence formed by the supinator longus and extensor carpi radialis longior and brevior muscles; it supplies the skin on the lower two-thirds of the back and outer part of the forearm, as far as the wrist, and communicates with a branch of the radial and the external cutaneous branch of the musculo-spiral.

The **inferior external cutaneous branch** of the musculo-spiral nerve enters the forearm in front of the outer condyle of the humerus, supplies the skin on the outer posterior part of the forearm, and terminates on the back of the hand. It communicates with the musculo-cutaneous or external cutaneous about the middle of the forearm.

The **lesser internal cutaneous nerve** terminates in the skin upon the inner side of the olecranon, and communicates with the internal cutaneous nerve.

The **posterior branch of the internal cutaneous nerve** enters the back of the forearm below the inner condyle of the humerus, and supplies the skin over the

inner posterior part of the forearm from the elbow to the wrist. It communicates with the dorsal branch of the ulnar nerve.

The **radial nerve** reaches the back of the forearm about three inches above the wrist, by passing under the tendon of the supinator longus muscle. Near the lower end of the radius it gives off a *palmar cutaneous branch* which supplies the radial margin of the hand and thumb, and then divides into four branches. Of these, one supplies the ulnar side of the thumb, another passes to the radial side of the index finger, a third divides into two branches to supply the adjacent sides of the index and middle fingers, and a fourth communicates with a branch from the dorsal branch of the ulnar to supply the contiguous margins of the middle and ring fingers.

The **dorsal cutaneous branch of the ulnar nerve.**—About three inches above the wrist the ulnar nerve gives off the dorsal cutaneous branch, which passes backward under the flexor carpi ulnaris and over the tendon of the extensor carpi ulnaris to the back of the wrist, where it divides into a communicating and two digital branches. The inner digital branch passes to the inner side of the little finger, while the outer digital branch passes to the middle of the fourth interosseous space, where it divides into two branches for the supply of the adjacent sides of the little and ring fingers. The communicating branch joins a filament from the radial nerve, and aids in the supply of the contiguous sides of the ring and middle fingers.

The **deep fascia** of the back of the forearm is stronger than that of the front. It is attached, above, to the external and internal condyles of the humerus and the olecranon, and here receives expansions from the bicipital fascia and the tendon of the triceps; it is also attached to the posterior border of the ulna, outer border of the lower end of the radius, and the pisiform and cuneiform bones. At the wrist the deep fascia is very dense, contains many transverse fibers, and forms the posterior annular ligament. Beyond the posterior annular ligament the deep fascia

lower end of the radius. By means of these processes six compartments are formed for the passage of the extensor tendons. They contain, from within outward, the tendons of the following muscles: The extensor carpi ulnaris, the extensor of the little finger (extensor minimi digiti), the extensor communis digitorum and extensor indicis, the extensor secundi internodii pollicis, the extensor carpi radialis longior and brevior, the extensor primii internodii pollicis, and extensor ossis metacarpi pollicis. Each of these compartments has a synovial lining which extends above and below the limits of the ligament. The sheaths of the extensor tendons, particularly those of the thumb, are not infrequently the site of inflammation (teno-synovitis), and in such cases there is a longitudinal swelling over the position of the tendon, due to increase in the amount of secretion in the synovial sheath. There is, also, a grating or crepitating sensation communicated to the surgeon's finger when the patient contracts the various muscles (tenalgia crepitans). Tubercular teno-synovitis may also occur here. Connected with the tendon sheaths, or, more commonly, with the periarticular structures of the wrist, we often meet with small, firm, oval, or round swellings which are rendered more prominent by flexion of the wrist, and are known as ganglia. They are more common in young girls.

The extensor sheaths of the tendons of the back of the hand are practically prolongations of the walls of the different compartments of the posterior annular ligament. They hold the same relations as the compartments, and inclose the same tendons which have been described as occupying the compartments of the posterior annular ligament.

The muscles exposed are the extensors of the hand and fingers. They consist of three sets—the radial, superficial, and deep extensors.

Radial extensors.—Supinator longus, extensor carpi radialis longior, and extensor carpi radialis brevior.

The **supinator longus, supinator radii longus or brachio-radialis,** arises from the upper two-thirds of the external condyloid ridge of the humerus, as high up as the musculo-spiral groove, and from the external intermuscular septum. It is a long fleshy muscle, the belly of which, with the other two muscles of this group,

recurrent artery; and below the elbow, the tendon of the biceps and the pronator radii teres.

BLOOD SUPPLY.—From the radial and radial recurrent arteries.

NERVE SUPPLY.—From the musculo-spiral nerve.

ACTION.—It slightly supinates the forearm, especially after full pronation, flexes the forearm, and in full supination is a slight pronator.

The **extensor carpi radialis longior** arises from the lower third of the external condyloid ridge of the humerus, the external intermuscular septum, and from the external condyle of the humerus by the common extensor tendon; the fibers terminate about the middle of the forearm in a flattened tendon, which passes down the outer side of the forearm to the wrist, and through a groove upon the back of the base of the radius just behind the styloid process, accompanied by the extensor carpi radialis brevior, to be inserted upon the radial side of the base of the metacarpal bone of the index finger. The muscle is overlapped on its outer anterior border by the supinator longus, and crossed at its lower end by the three extensors of the thumb. It lies upon the elbow-joint, extensor carpi radialis brevior, and dorsum of the wrist.

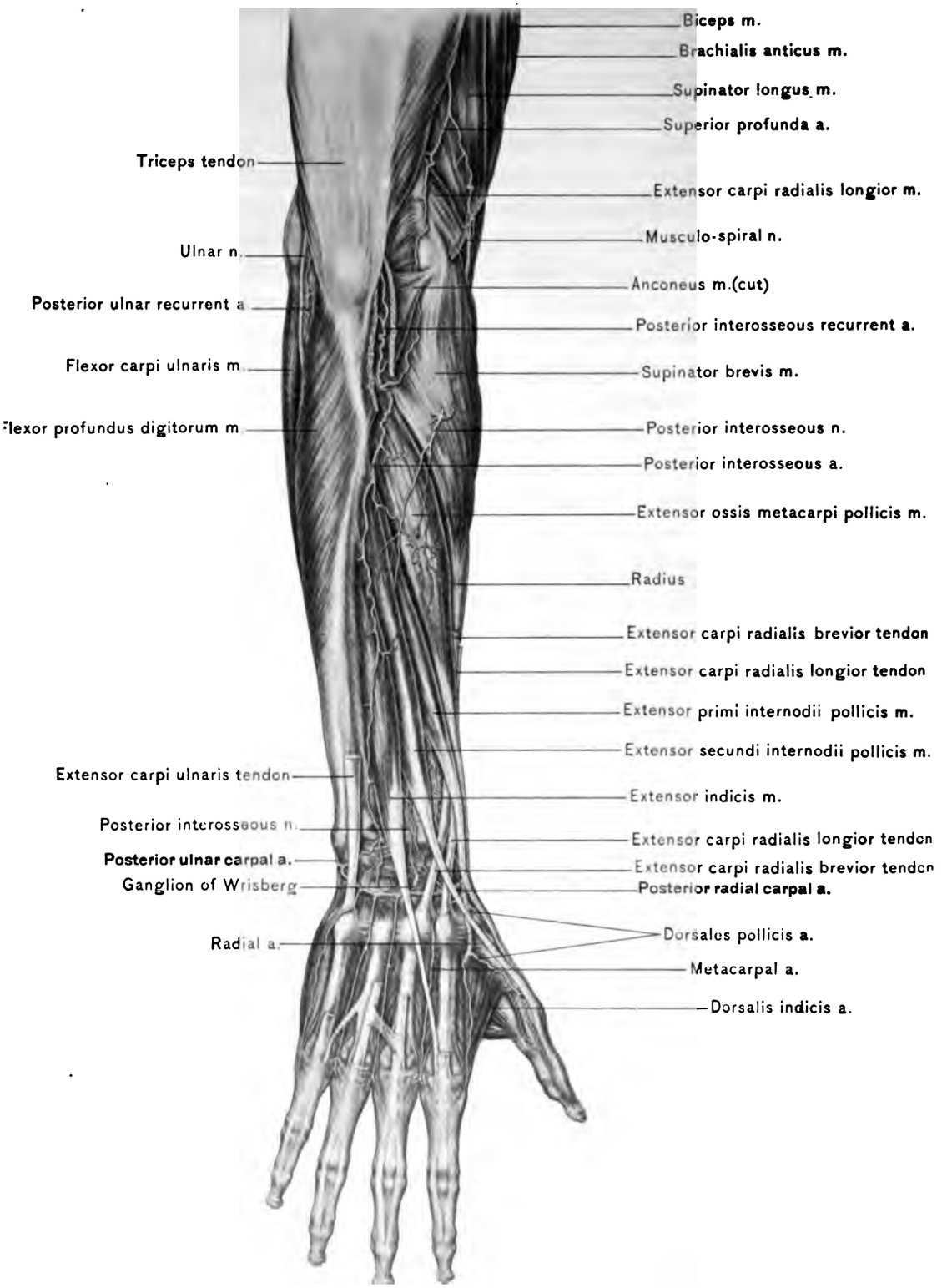
BLOOD SUPPLY.—From the radial and radial recurrent arteries.

NERVE SUPPLY.—From the musculo-spiral nerve.

ACTION.—It extends and abducts the wrist and flexes the elbow.

The **extensor carpi radialis brevior** arises from the external condyle of the humerus; the adjacent intermuscular septum, the external lateral ligament of the elbow-joint, and the deep fascia. In the middle of the forearm it ends in a flattened tendon which lies close to and accompanies that of the extensor carpi radialis longior down the forearm. It passes through the groove upon the base of the radius and is inserted into the radial side of the base of the metacarpal bone of the middle finger. It and the tendon of the extensor carpi radialis longior occupy the same sheath and pass through the same compartment of the posterior annular ligament. Above it is covered by the extensor carpi radialis longior, and below by the extensors of the thumb. It rests upon the supinator brevis, the

LATE LV.


Biceps m.
Brachialis anticus m.
Supinator longus m.
Superior profunda a.
Triceps tendon
Extensor carpi radialis longior m.
Musculo-spiral n.
Ulnar n.
Anconeus m.(cut)
Posterior ulnar recurrent a.
Posterior interosseous recurrent a.
Flexor carpi ulnaris m.
Supinator brevis m.
Flexor profundus digitorum m.
Posterior interosseous n.
Posterior interosseous a.
Extensor ossis metacarpi pollicis m.
Radius
Extensor carpi radialis brevior tendon
Extensor carpi radialis longior tendon
Extensor primi internodii pollicis m.
Extensor secundi internodii pollicis m.
Extensor carpi ulnaris tendon
Extensor indicis m.
Posterior interosseous n.
Extensor carpi radialis longior tendon
Posterior ulnar carpal a.
Extensor carpi radialis brevior tendon
Ganglion of Wrisberg
Posterior radial carpal a.
Dorsales pollicis a.
Radial a.
Metacarpal a.
Dorsalis indicis a.

intermuscular septa. Just below the middle of the forearm it divides into three tendons which pass, with the extensor indicis, through a common compartment in the posterior annular ligament, whence they diverge for insertion into the bases of the second and third phalanges of the four fingers. The muscle is subcutaneous, except where its tendons pass beneath the posterior annular ligament, and lies upon the supinator brevis, extensors of the thumb and index finger, the posterior interosseous nerve and vessels, the carpus and the dorsal interossei muscles. On its ulnar side are the extensor minimi digiti and extensor carpi ulnaris.

BLOOD SUPPLY.—From the posterior interosseous artery.

NERVE SUPPLY.—From the posterior interosseous nerve.

ACTION.—Its chief function is to extend the phalanges; continuing its action it extends the wrist-joint and, to a slight extent, the elbow.

The **extensor minimi digiti muscle** lies upon the ulnar side of the extensor communis digitorum muscle, and is generally connected therewith. It arises from the external condyle of the humerus by the common extensor tendon, from the deep fascia, and the adjacent intermuscular septa. It becomes tendinous in the lower part of the forearm, and passes behind the radio-ulnar joint through a separate compartment of the posterior annular ligament of the wrist. It passes to the back of the little finger after uniting with the tendon of the extensor communis digitorum. It is covered above by the extensor communis digitorum and extensor carpi ulnaris, but is superficial below, except where it lies beneath the posterior annular ligament. It rests upon the supinator brevis, the extensor ossis metacarpi pollicis, the extensor secundi internodii pollicis, and the extensor indicis.

BLOOD SUPPLY.—From the posterior interosseous artery.

NERVE SUPPLY.—From the posterior interosseous nerve.

ACTION.—It extends the wrist-joint, the metacarpo-phalangeal and the inter-phalangeal joints of the little finger.

The **extensor carpi ulnaris muscle** arises, by the common extensor tendon, from the external condyle of the humerus, from the middle third of the posterior border of the ulna in common with the flexor carpi ulnaris and flexor profundus digitorum, and from the deep fascia. It lies, superficially, upon the ulnar side of the forearm, and ends in a tendon which goes through a groove, back of the styloid process of the ulna and beneath the posterior annular ligament, to be inserted into the base of the metacarpal bone of the little finger. It is subcutaneous, except where it lies beneath the posterior annular ligament, and rests upon the supinator brevis, extensor ossis metacarpi pollicis, and extensores primi and secundi internodii pollicis, extensor indicis, the ulna, and the carpus. Its ulnar

BLOOD SUPPLY.—From the posterior interosseous artery.

NERVE SUPPLY.—From the posterior interosseous nerve.

ACTION.—It extends the elbow-joint and adducts and extends the wrist-joint.

The **anconeus** is a small and triangular-shaped muscle, situated upon the outer side of the olecranon. It arises from the back of the external condyle of the humerus and the posterior ligament of the elbow-joint. From this origin its fibers diverge for insertion into the outer side of the olecranon and upper one-fourth of the shaft of the ulna. It is superficial and lies against the elbow-joint, the orbicular ligament, the ulna, and a part of the supinator brevis. Its upper edge is in contact with and parallel to the lowermost fibers of the outer head of the triceps; its lower and outer margin adjoins the extensor carpi ulnaris.

BLOOD SUPPLY.—From the interosseous recurrent artery.

NERVE SUPPLY.—From the musculo-spiral nerve.

ACTION.—It extends the elbow-joint.

DISSECTION.—The extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris should now be severed in the middle of the forearm, and reflected upward and downward so that greater facility for the study of the following muscles may be afforded.

Deep Extensors: Supinator brevis, extensor ossis metacarpi pollicis, extensor primi internodii pollicis, extensor secundi internodii pollicis, and extensor indicis.

The **supinator radii brevis or supinator brevis** is a broad, flat muscle, irregular in outline, and wrapped about the upper end of the radius. It arises from the external condyle of the humerus, the external lateral ligament of the elbow-joint, the orbicular ligament of the radius, the depression below the lesser sigmoid cavity of the ulna, and the fascia enveloping the muscle. Its upper fibers, arranged as a loop, surround the neck of the radius, and are inserted into the back of its inner surface, while the remainder of the muscle is attached to the anterior and outer surface of the radius, from the oblique line and bicipital tuberosity to the insertion of the pronator radii teres. It is covered in front and externally by the biceps, pronator radii teres, supinator longus, extensores carpi radialis longior and brevior, and the radial vessels and nerve; behind by the anconeus, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, and the interosseous recurrent artery. It rests upon the elbow-joint, the superior radio-

PLATE LVI

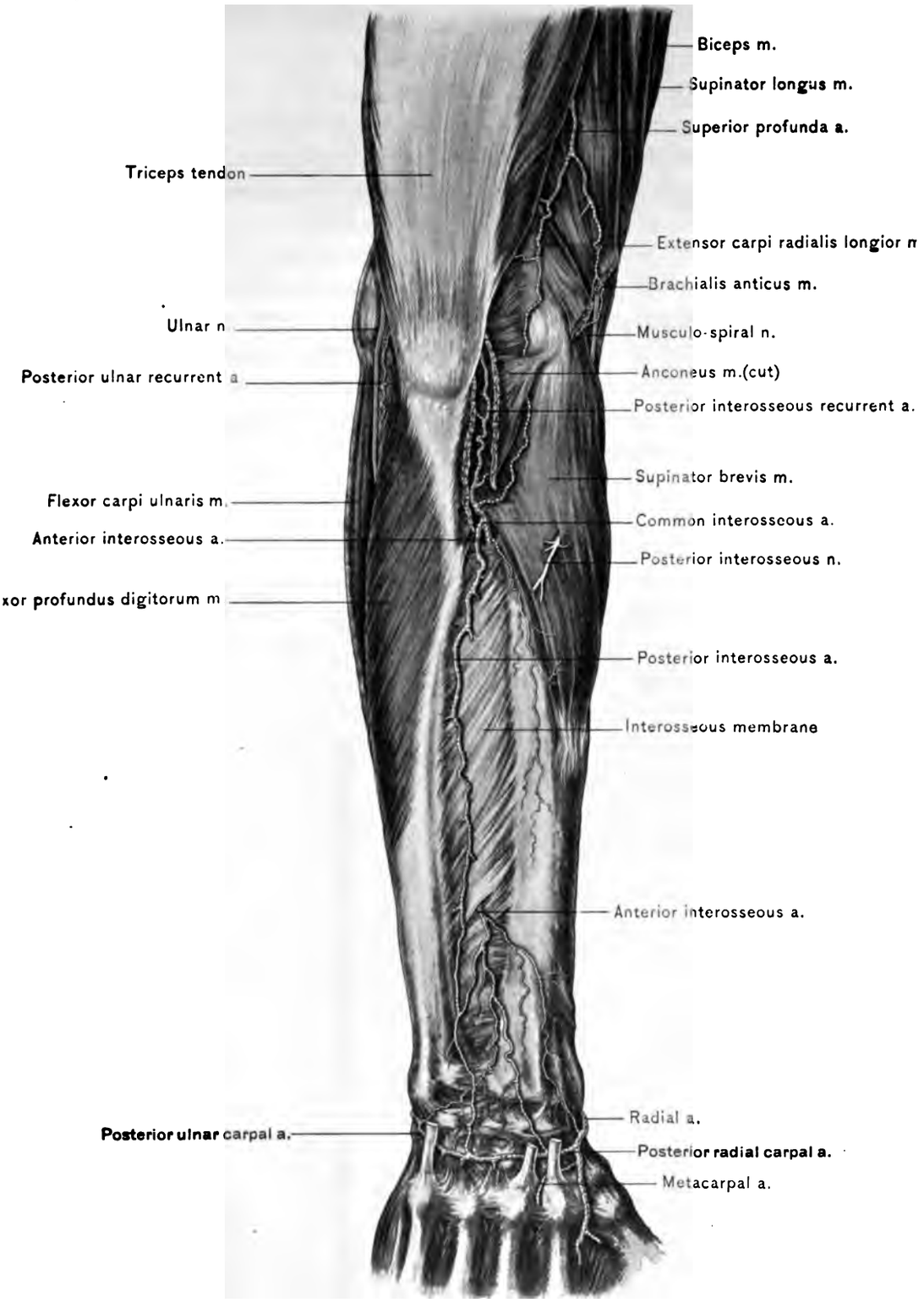
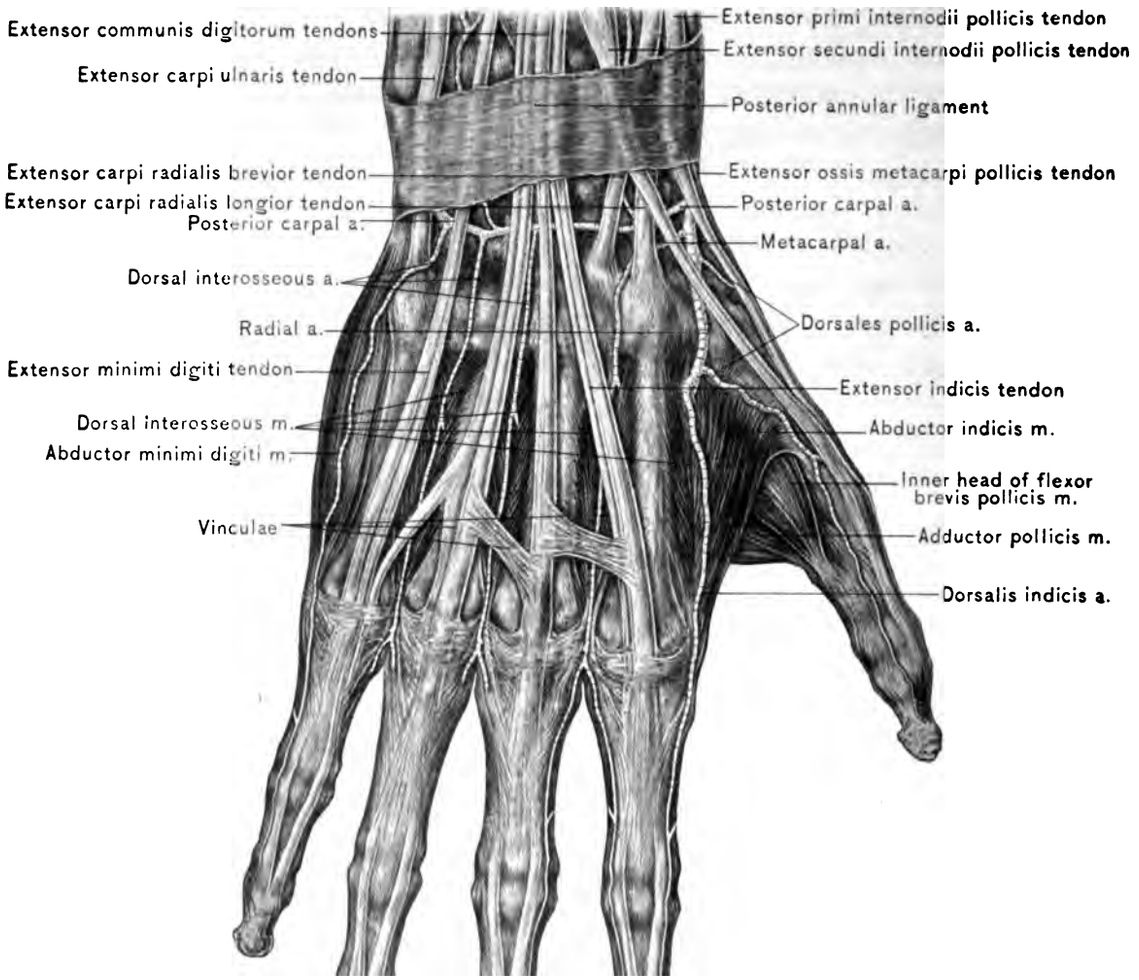

Biceps m.
Supinator longus m.
Superior profunda a.
Triceps tendon
Extensor carpi radialis longior m
Brachialis anticus m.
Ulnar n
Musculo-spiral n.
Posterior ulnar recurrent a
Anconeus m.(cut)
Posterior interosseous recurrent a.
Supinator brevis m.
Flexor carpi ulnaris m.
Common interosseous a.
Anterior interosseous a.
Posterior interosseous n.
xor profundus digitorum m
Posterior interosseous a.
Interosseous membrane
Anterior interosseous a.
Radial a.
Posterior ulnar carpal a.
Posterior radial carpal a.
Metacarpal a.

PLATE LVII.


Extensor communis digitorum tendons
Extensor carpi ulnaris tendon
Extensor carpi radialis brevior tendon
Extensor carpi radialis longior tendon
Posterior carpal a.
Dorsal interosseous a.
Radial a.
Extensor minimi digiti tendon
Dorsal interosseous m.
Abductor minimi digiti m.
Vinculae
Extensor primi internodii pollicis tendon
Extensor secundi internodii pollicis tendon
Posterior annular ligament
Extensor ossis metacarpi pollicis tendon
Posterior carpal a.
Metacarpal a.
Dorsales pollicis a.
Extensor indicis tendon
Abductor indicis m.
Inner head of flexor brevis pollicis m.
Adductor pollicis m.
Dorsalis indicis a.

The **extensor ossis metacarpi pollicis muscle** arises from the back of the shaft of the radius and ulna from a surface about two inches long and just below the inferior margins of the supinator brevis and anconeus muscles, and the intervening interosseous membrane. It passes obliquely downward and outward, its tendon going through a groove upon the radius, external to the styloid process and in common with that of the extensor primi internodii pollicis, to be inserted into the radial side of the base of the metacarpal bone of the thumb. It is covered by the extensores communis digitorum, carpi ulnaris, and minimi digiti, and the posterior annular ligament, and is crossed by the posterior interosseous nerve and vessels. It lies upon the ulna, interosseous membrane, radius, extensores primi internodii pollicis and secundi internodii pollicis, tendons of the extensores carpi radialis longior and brevior, the radial vessels, and the wrist-joint. Above it are the supinator brevis and anconeus, and below it the extensores primi and secundi internodii pollicis.

BLOOD SUPPLY.—From the posterior interosseous artery.

NERVE SUPPLY.—From the posterior interosseous nerve.

ACTION.—It abducts and extends the metacarpal bone of the thumb, abducts the wrist-joint, and supinates the forearm.

The **extensor primi internodii pollicis,** or **extensor brevis pollicis muscle,** the smallest of the extensors of the thumb, arises from the back of the shaft of the radius and the interosseous membrane just below the extensor ossis metacarpi pollicis muscle, and takes a course parallel with that muscle and external to the styloid process of the radius. It passes through the same groove as the extensor ossis metacarpi pollicis to be inserted into the base of the first phalanx of the thumb. It lies upon the radius and interosseous membrane, the tendons of the extensores carpi radialis longior and brevior, the radial vessels, the wrist-joint, the metacarpal bone of the thumb, and the metacarpo-phalangeal joint of the thumb. Its upper border is in relation with the preceding muscle. It is covered by the extensor ossis metacarpi pollicis, extensor communis digitorum, extensor minimi digiti, and the posterior annular ligament.

BLOOD SUPPLY.—From the posterior interosseous artery.

NERVE SUPPLY.—From the posterior interosseous nerve.

ACTION.—It extends the first joint of the thumb, abducts and extends the metacarpal bone of the thumb, and abducts the hand.

The **extensor secundi internodii pollicis,** or **extensor longus pollicis muscle,** larger than the preceding muscle, arises from the back of the shaft of the ulna and

carpi radialis longior and brevior, for insertion into the back of the base of the last phalanx of the thumb. At the wrist, in the triangular interval between the extensor secundi internodii pollicis and the other two thumb extensor tendons, the radial artery will be found. The muscle and tendon are covered by the extensor ossis metacarpi pollicis, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, the posterior interosseous artery and posterior annular ligament. It rests upon the interosseous membrane, the tendons of the extensores carpi radialis longior and brevior, the radius, the wrist-joint, the radial vessels, the metacarpal bone of the thumb and its proximal phalanx.

Blood Supply.—From the posterior interosseous artery.

Nerve Supply.—From the posterior interosseous nerve.

Action.—It extends all of the thumb-joints, adducts the metacarpal bone of the thumb, abducts the hand, and supinates the forearm.

The **extensor indicis muscle,** narrow and elongated, arises from the back of the ulna and the interosseous membrane, below the attachment of the extensor secundi internodii pollicis muscle, whence it passes, with the outer tendon of the extensor communis digitorum, through the same compartment, beneath the posterior annular ligament, to be inserted into the inner side of that tendon. It is covered by the extensor communis digitorum, extensor minimi digiti, extensor secundi internodii pollicis, and the posterior annular ligament. It lies upon the interosseous membrane, the wrist, and the dorsal interosseous muscle of the second interosseous space.

Blood Supply.—From the posterior interosseous artery.

Nerve Supply.—From the posterior interosseous nerve.

Action.—It extends the wrist-joint, the metacarpo-phalangeal and the interphalangeal joints of the index-finger.

The **posterior interosseous artery** is the branch of the common interosseous which passes backward between the bones of the forearm and the upper border of the interosseous membrane and oblique ligament. It emerges behind, between the supinator brevis muscle above and the extensor ossis metacarpi pollicis muscle below,

and olecranon process of the ulna; it anastomoses with the superior profunda, anastomotica magna, radial recurrent, and posterior ulnar recurrent arteries. The *muscular branches* of the posterior interosseous artery supply the muscles between which it lies. The *articular branches* supply the wrist-joint.

The *terminal portion of the* **anterior interosseous artery** is seen lying on the posterior surface of the lower part of the interosseous membrane, where it is joined by a branch of the posterior interosseous artery. It runs downward over the wrist, beneath the extensor tendons, and anastomoses with the posterior carpal arch.

The **posterior interosseous nerve** winds around the outer side of the upper end of the radius, through the substance of the supinator brevis muscle, to the back of the forearm, whence it passes downward, in company with the posterior interosseous artery, between the superficial and deep extensor muscles, to the upper border of the extensor secundi internodii pollicis. In the forearm it supplies *muscular branches* to the extensor carpi radialis brevior, supinator brevis, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, extensor ossis metacarpi pollicis, extensores primi and secundi internodii pollicis, and extensor indicis. At the upper border of the extensor secundi internodii pollicis muscle the posterior interosseous nerve leaves the posterior interosseous artery and runs beneath the extensor secundi internodii pollicis and extensor indicis, upon the interosseous membrane, and accompanies the terminal part of the anterior interosseous artery to the back of the wrist. Here it ends in a gangliform enlargement which gives off *articular filaments* to the wrist and intercarpal joints.

After blows upon the front of the external condyle or outer side of the upper one-fifth of the radius, the condition of the posterior interosseous nerve may cause spasm or paralysis of the supinator brevis and the extensors of the wrist and fingers, excepting the radial extensors which are supplied by branches of the musculo-spiral before it bifurcates.

THE BACK OF THE HAND.

The superficial veins, nerves, and deep fascia of the back of the hand having been described when the posterior surface of the forearm was considered, it remains to reflect the deep fascia from above downward in order to expose the extensor tendons and remaining deep structures of the back of the hand.

The **extensor tendons** emerge from beneath the [illegible]

extensor communis digitorum become narrow and thickened opposite the metacarpo-phalangeal joints, at which point they give off fasciculi which are attached to the lateral ligaments of these articulations. They then form a broad aponeurosis which covers the entire back of the first phalanges, where they are joined by the tendons of the interossei and lumbricales muscles. Opposite the first interphalangeal joint each tendon divides into a middle slip which is inserted into the base of the second phalanx, and two lateral slips which unite over the middle phalanx, for insertion into the back of the base of the terminal phalanx. These tendons constitute the posterior ligaments of the metacarpo-phalangeal and interphalangeal joints. On the proximal side of the metacarpo-phalangeal articulations the tendon of the ring finger sends off two lateral divergent slips, which are attached to the adjacent tendons of the little and middle fingers. This is important because it restricts the independent extension of the ring finger, a defect especially troublesome in pianists and violinists, who, sometimes, on account of this interference with the required movement, have these restricting bands divided. The tendon of the middle finger is also connected to the extensor communis tendon of the index finger by a band of transverse fibers. The tendon of the extensor indicis joins that of the common extensor over the first phalanx of the index finger. The tendon of the extensor minimi digiti divides, one part joining the common extensor tendon of the little finger, the other ending in the dorsal expansion common to this tendon and that of the tendon of the extensor communis digitorum.

DISSECTION.—Remove the fascia overlying the dorsal interossei muscles and the vessels of the back of the wrist and hand. The vessels on the back of the wrist and hand are the radial artery and its branches, which will be described below, the posterior carpal branch of the ulnar artery, and the terminal portion of the anterior interosseous artery.

The **radial artery,** as it leaves the front of the forearm, first lies upon the external lateral ligament of the wrist, then upon the scaphoid, trapezium, and base of the metacarpal bone of the thumb, and under the tendons of the extensores

dorsal digital branches which supply the contiguous sides of the middle, ring, and little fingers. At the carpal ends of the interosseous spaces they are joined by the perforating branches of the deep palmar arch. At the distal ends of the interosseous spaces they give off *anterior perforating* branches which join the digital arteries of the corresponding intervals. The posterior carpal arch is joined by the terminal portion of the anterior interosseous artery. The *posterior carpal branch of the ulnar artery* arises from the latter vessel a short distance above the pisiform bone, and winds around the ulna beneath the flexor carpi ulnaris to the back of the wrist, where it lies beneath the extensor tendons and anastomoses with the posterior carpal branch of the radial artery to form the posterior carpal arch which has been described above. The terminal portion of the anterior interosseous artery has been described with the back of the forearm.

The **metacarpal or first dorsal interosseous artery** generally arises from the radial, although, at times, it comes from the posterior carpal arch. It passes downward over the second interosseous space and divides into dorsal digital branches which supply the adjacent sides of the index and middle fingers. Like the second and third interosseous arteries it is joined by a perforating branch from the deep palmar arch, and gives off an *anterior perforating branch* to join the corresponding digital artery.

The **dorsal digital arteries** terminate at the first interphalangeal joints, where they anastomose with the posterior branches of the collateral digital arteries.

The **dorsales pollicis arteries,** two branches, arise from the radial near the base of the first metacarpal bone, and pass downward on either side of the thumb.

The **dorsalis indicis artery** arises from the radial immediately before it passes into the palm, and runs over the abductor indicis muscle, on the radial side of the metacarpal bone and first phalanx of the index finger, to anastomose opposite the first interphalangeal joint with a posterior branch of the radialis indicis artery.

The **dorsal interossei** are four bipenniform muscles which arise from the adjacent sides of the proximal one-half or two-thirds of the shafts of the metacarpal

phalanx and the extensor tendon of the ring finger. The intervals between the bases of the metacarpal bones and the converging fibers of the proximal ends of the muscles permit the passage of the perforating branches from the deep palmar arch. The interval between the origins of the first dorsal interosseous muscle gives passage to the radial artery.

BLOOD SUPPLY.—These muscles are supplied by the deep palmar and posterior carpal arches.

NERVE SUPPLY.—From the deep branch of the ulnar nerve.

ACTION.—They are abductors of the fingers, flex the metacarpo-phalangeal joints, and extend the last two phalanges. The action of the first dorsal interosseous (abductor indicis) is clearly demonstrated by abducting the index finger, flexing its metacarpo-phalangeal joint, and keeping the last two phalanges extended, thus contracting the muscle, which can be plainly felt and seen on the back of the hand in the first interosseous space.

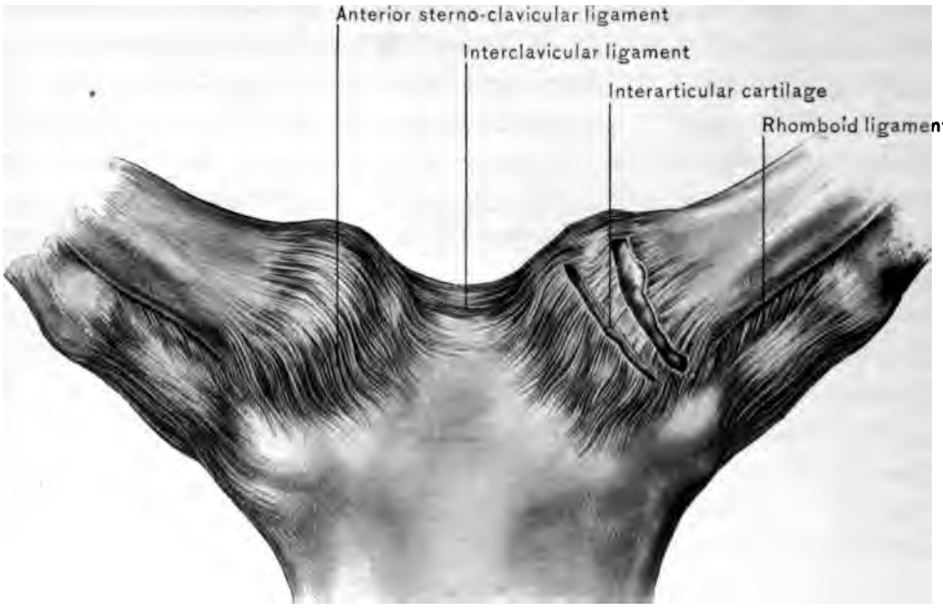
JOINTS.

A **joint** is composed of the adjacent portions of two or more bones, articular cartilage, ligaments, and one or two synovial membranes.

The **articular ends of the bones** are chiefly composed of cancellous tissue, which gives strength, elasticity, a large surface for articulation, and a minimum weight. At the articular surface the cancellous tissue is covered by a thin crust of dense, compact bone which contains no Haversian canals. The articular ends of the long bones are supplied by the articular arteries, and thus have a blood supply independent of that furnished to the shaft by the nutrient artery. This portion of the bone is occasionally affected by inflammation, which is frequently tubercular in character. If the diseased tissue is not removed and drainage instituted, the thin crust of compact bone upon the articular surface offers but slight obstruction to the inflammatory process, and the articular cartilage and joint may soon become involved.

The **articular cartilage** covers the smooth articular ends of the bones. It is of the hyaline variety, and contains no blood-vessels. It receives its nourishment through lymph channels which pass between the cartilage cells. The lymph is derived from the vessels in the ends of the bones and in the synovial membrane of the joint; therefore, if the cartilage be partially detached from the bone by external violence, the detached area loses more or less of its blood supply, and necrosis may result. In rheumatoid arthritis this cartilage disappears and the

PLATE LVIII.



STERNO-CLAVICULAR JOINT,—ANTERIOR VIEW.

Interclavicular ligament

Posterior sterno-clavicular ligament

Rhomboid ligament

A **synovial membrane** is found in all true joints. In joints like the temporo-maxillary, which have an interarticular cartilage subdividing the joint, there are two synovial sacs. This membrane lines the ligaments of the joint and fades away at the margin of the articular cartilage, where it is continuous with the surface of the cartilage. The synovial membranes resemble serous membranes, and, like them, are composed of flat endothelial cells. They secrete the synovial fluid which lubricates the joints. Inflammation of joints begins in this membrane more frequently than in other parts of the joint. Because of the close relation between the membrane and the ligaments, the latter are likely to be involved. In tubercular arthritis the softening of the ligaments permits increased lateral motion of the joint, whereas the infiltration and contraction of the ligaments and bands of adhesions in rheumatic arthritis cause stiffness and false ankylosis of the joint.

For practical purposes all joints may be divided into three classes: Those which derive their strength chiefly from the conformation of the bones, those whose strength depends upon their ligaments, and those which largely depend upon surrounding muscles for support. The hip-joint is the best example of the first class. External violence applied to such a joint is more likely to produce a contusion than a sprain or dislocation. In joints of the second class, such as the radio-ulnar, a sprain is more common than a contusion or a dislocation. In joints of the third class, the best example of which is the shoulder, dislocation is more common than contusion or sprain.

In the diagnosis of fractures, dislocations, and diseases of joints of the extremities it is always advisable to compare the affected with the non-affected member.

JOINTS OF THE UPPER EXTREMITY.

The joints of the upper extremity include the sterno-clavicular, the scapulo-clavicular, the shoulder or scapulo-humeral, the elbow, the superior and inferior radio-ulnar, the radio-carpal or wrist, the intercarpal or medio-carpal, the carpo-metacarpal, the metacarpo-phalangeal, and the interphalangeal.

THE STERNO-CLAVICULAR JOINT.

The **sterno-clavicular,** an arthrodial joint, is formed by the upper outer part of the manubrium sterni and the inner end of the clavicle, which is larger than the bed or articulating surface of the manubrium in which it rests. The first

are bound together by five ligaments: The anterior sterno-clavicular, the posterior sterno-clavicular, the interclavicular, the costo-clavicular or rhomboid, and the interarticular fibro-cartilage.

The **anterior sterno-clavicular ligament,** which covers the front of the joint, is a fibrous membrane extending from the superior and anterior surface of the inner end of the clavicle to the superior and anterior surface of the manubrium sterni. It is covered by the skin, the fasciæ, and the sternal origin of the sterno-cleido-mastoid, and it is in relation posteriorly with the interarticular fibro-cartilage and the two synovial sacs.

The **posterior sterno-clavicular ligament** is attached to the back of the inner end of the clavicle and to the manubrium sterni in a manner similar to that of the anterior ligament. Anterior to the ligament are the interarticular fibro-cartilage and the two synovial sacs; posterior to it are the sterno-hyoid and sterno-thyroid muscles.

The **interclavicular ligament** is a strong fibrous band which varies considerably in size, and extends from the superior surface of the sternal end of one clavicle to the same part of the other. It is attached to the superior surface of the manubrium sterni between the ends of the clavicles, and is covered in front by the skin and fasciæ, while behind it is in relation with the sterno-thyroid muscles.

The **costo-clavicular (rhomboid) ligament,** short, flat, and quadrangular in shape, is attached below to the upper surface of the inner end of the cartilage of the first rib, and above to the rhomboid depression on the under surface of the sternal end of the clavicle. It lies behind the tendon of origin of the subclavius muscle and in front of the subclavian vein. In order to expose the interarticular fibro-cartilage sever the costo-clavicular and the anterior sterno-clavicular ligament.

The **interarticular cartilage,** a flat disc nearly corresponding in size and outline to the sternal end of the clavicle, is situated between the end of the clavicle and the clavicular notch of the sternum, where it acts as a buffer and prevents the clavicle from being pushed inward over the sternum. Below it is attached to the

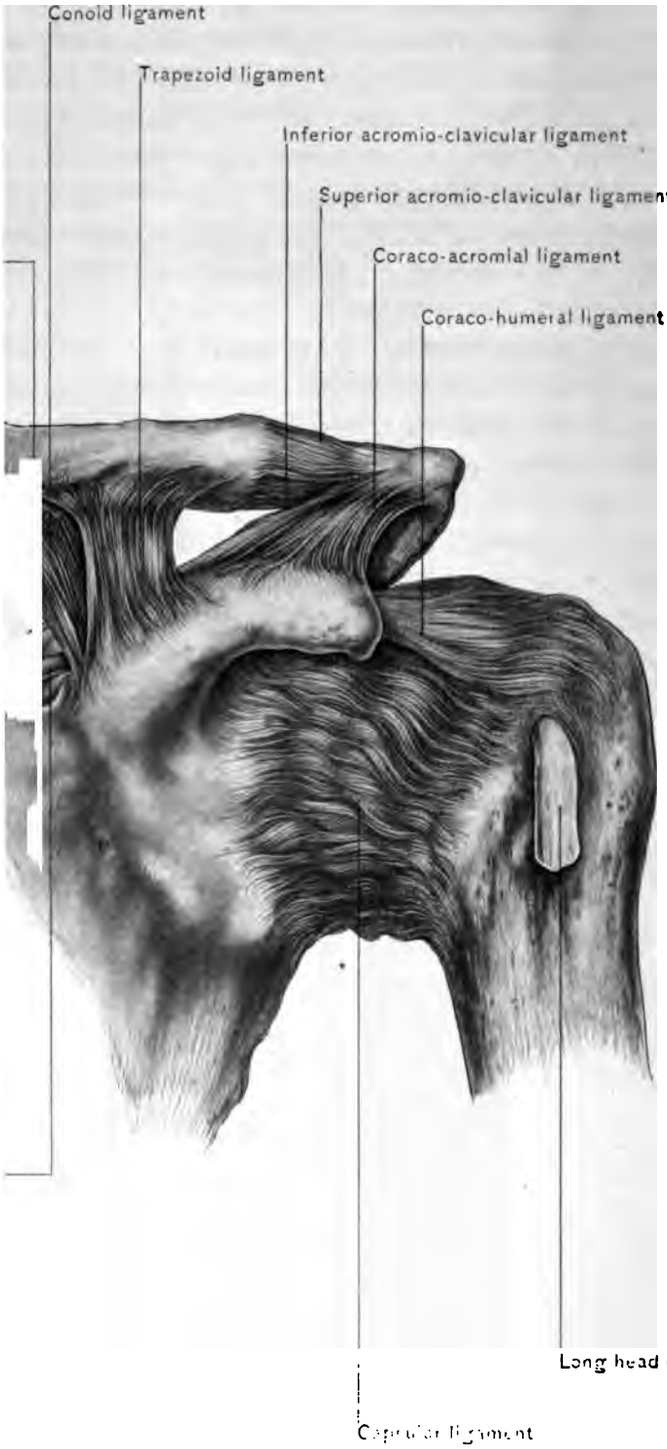
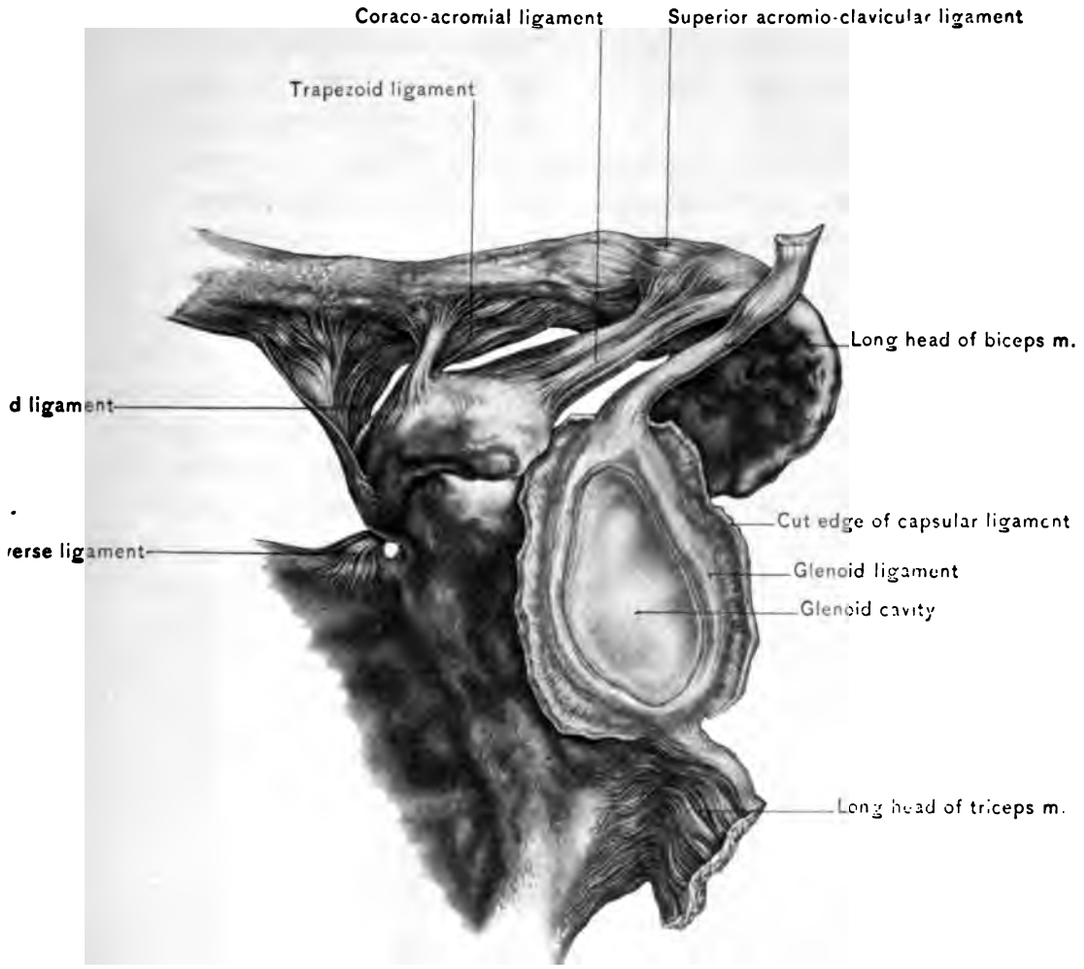

Conoid ligament
Trapezoid ligament
Inferior acromio-clavicular ligament
Superior acromio-clavicular ligament
Coraco-acromial ligament
Coraco-humeral ligament
Long head of biceps m.
Capsular ligament

PLATE LX.


Coraco-acromial ligament
Superior acromio-clavicular ligament
Trapezoid ligament
Long head of biceps m.
d ligament
erse ligament
Cut edge of capsular ligament
Glenoid ligament
Glenoid cavity
Long head of triceps m.

NERVE SUPPLY.—The nerve supply of the joint is derived from the branch of the brachial plexus which supplies the subclavius muscle.

MOVEMENTS.—This joint is the center of *motion* for the shoulder, and admits of circumduction and of limited movement upward, downward, forward, and backward. Dislocation of the clavicle at this articulation does not often occur, for the combined strength of the ligaments is considerable, and compensates for the lack of adaptation of the articular surfaces of the bones. The adjacent muscles assist in preventing luxation.

THE SCAPULO-CLAVICULAR JOINT.

The **scapulo-clavicular,** an arthrodial joint, is formed by the acromial end of the clavicle and the acromion process of the scapula. The bones are held in place by the ligaments proper, which are the superior acromio-clavicular, the inferior acromio-clavicular, and the interarticular fibro-cartilage. The coraco-clavicular is an accessory ligament.

The **superior acromio-clavicular ligament** covers the upper surface of the joint and is attached to the contiguous margins of the two bones. It is quadrilateral in shape, and composed of parallel transverse fibers which interlace with the tendinous fibers of the trapezius and deltoid muscles. It is covered by skin and fasciæ.

The **inferior acromio-clavicular ligament** is the counterpart of the preceding, covers the under surface of the joint, and is similarly attached. Below it is in relation with the tendon of the supra-spinatus muscle. These two ligaments are continuous around the joint and constitute its capsule.

An **interarticular fibro-cartilage** sometimes exists in this joint. When present it is rarely a complete disc, and occupies the upper part of the joint. There is but one synovial membrane. The cartilage when present can be exposed by dividing the superior acromio-clavicular ligament.

The **coraco-clavicular ligament**—composed of two parts, the trapezoid and conoid—connects the clavicle and the coracoid process of the scapula. The *trapezoid ligament,* the anterior of the two, is quadrilateral in shape, and is attached to the upper surface of the coracoid process and to the oblique ridge on the under surface of the clavicle. Behind it is continuous with the conoid ligament, while in front and externally it has a free margin The *conoid ligament,* triangular in shape, is attached by its apex to a rough impression upon the base of the coracoid process on the inner side of the trapezoid ligament; by its base to the conoid tubercle, and for half an inch to a ridge on the under surf

In front and externally the conoid l

This ligament is in relation with the subclavius and deltoid muscles in front, and with areolar tissue, fat, and the insertion of the trapezius behind.

MOVEMENTS.—This joint permits a slight gliding, rotatory, or forward and backward movement, limited by the two portions of the coraco-clavicular ligament.

Upward dislocation of the outer end of the clavicle is not uncommon; it is characterized by an undue prominence of the outer end of the bone.

BLOOD SUPPLY.—The nourishment of the joint is derived from the supra-scapular, acromio-thoracic, and posterior circumflex arteries.

NERVE SUPPLY.—The supra-scapular and circumflex nerves supply the articulation.

The **ligaments proper** of the scapula are the coraco-acromial and the transverse ligaments.

The **coraco-acromial ligament,** triangular in shape, is attached by its base to the entire outer border of the coracoid process; by its apex to the tip of the acromion process. It completes the coraco-acromial arch, which is above the head of the humerus. It is covered by the clavicle and deltoid muscle and separated from the capsular ligament of the shoulder-joint by a bursa.

The **transverse or supra-scapular ligament** bridges over the supra-scapular notch, converting it into a foramen which gives passage to the supra-scapular nerve. The supra-scapular vessels pass over it.

In **dislocation of the scapula** the inferior angle of the bone slips from under the upper portion of the latissimus dorsi muscle, and the condition which results is "winged scapula." The causes are general weakness of the muscles, as in pulmonary tuberculosis and paralysis of the serratus magnus muscle. The inferior angle is normally held against the chest by the latissimus dorsi and serratus magnus, consequently any condition which weakens these muscles allows this angle to project. In the treatment of this condition the scapula should be held against the chest by a broad belt, so that the extent of movement of the arm will

The **capsular ligament** is attached to the margin of the glenoid cavity of the scapula and to the anatomic neck of the humerus. The capsule is very loose, or sacciform, to permit free movement; it is thickest above. The capsular ligament is perforated at three points: Above, where the bursæ beneath the tendons of the infra-spinatus and subscapularis communicate with the shoulder-joint, and on the outer side, where the long tendon of the biceps pierces it between the tuberosities of the humerus. The three *gleno-humeral bands* or ligaments are merely thickened portions of the capsule on its inner and anterior aspect.

The **coraco-humeral or accessory ligament** is a thickening of the part of the capsule extending from the outer border of the coracoid process to the greater tuberosity of the humerus, some of the fibers being raised from the capsule and thus becoming dignified into a separate ligament.

The **glenoid ligament** is a dense fibro-cartilaginous rim situated upon the edge of the glenoid cavity and possessing a wide attachment and thin border; it is continuous above with the long head of the biceps, and below with the long head of the triceps. It deepens the glenoid cavity and protects both the edge of the cavity and the head of the humerus from the effects of sudden impacts and severe pressure.

The **synovial membrane** lines the ligamentous walls of the joint, is reflected upon the neck of the humerus and is continuous with the margin of the articular cartilage which covers the head of the humerus and the glenoid cavity of the scapula. It sends a reflection around the long tendon of the biceps where it lies within the capsule of the joint and above the head of the humerus, and has communication with a bursal sac situated between the capsule and the tendon of the subscapularis muscle, and occasionally, with another bursal sac placed between the capsule and the tendon of the infra-spinatus. A large bursa, which, however, does not communicate with the shoulder-joint, lies between the deltoid muscle and the capsular ligament. Through the communications which exist between the joint cavity and these synovial bursæ pus may find its way to the surface, and ultimately form sinuses.

In **acute synovitis** of the shoulder-joint the synovial sac becomes distended with fluid, and as the synovial sac in relation with the long head of the biceps is a process of the synovial membrane of the joint, a fluctuating swelling may be detected upon each side of that tendon. The arm is lengthened by the pressure of the fluid; it may be lifted into its normal position, but it immediately lengthens

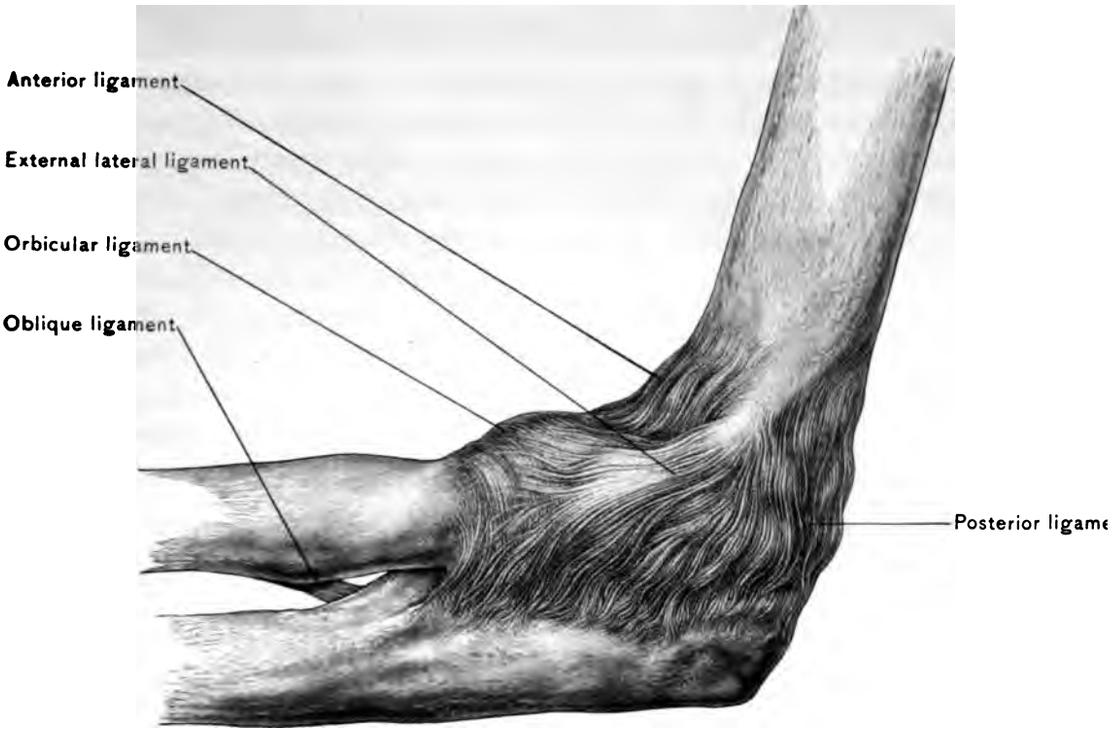
marked in abduction of the arm, as this movement causes compression of the bursa.

The muscles protecting the joint are, in front, the subscapularis; above, the supra-spinatus and long tendon of the biceps; behind, the infra-spinatus and teres minor; below, the long head of the triceps. The deltoid covers the joint above and behind, and, while protecting it from direct injury, aids in the retention of the head of the humerus within its socket. The joint is also protected above by the acromio-clavicular arch and the coraco-acromial ligament. The long tendon of origin of the biceps, lying between the tuberosities of the humerus in an osteo-fibrous canal, strengthens the joint and steadies the head of the humerus in its various movements.

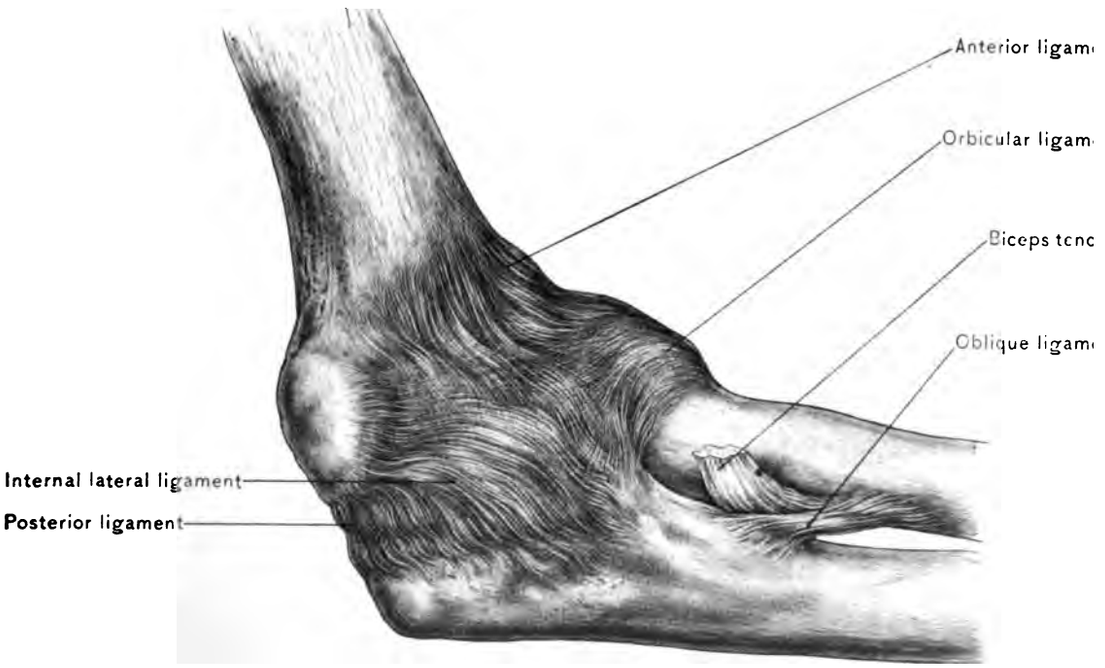
Movement in all directions, affording gliding, anteduction, retroduction, adduction, abduction, and circumduction, is possible at the shoulder-joint. The most limited movements are backward and upward. Persistence in the former movement causes the scapula to recede toward the median line of the body, and, in the latter, the inferior scapular angle to rotate forward and outward. In cases of ankylosis of the shoulder-joint the movement of the scapula compensates, to a certain extent, for the loss of motion in the scapulo-humeral articulation. Free movement in the shoulder-joint is permitted by the small glenoid cavity and large rounded articulating surface of the head of the humerus and the laxity of the capsular ligament. Although the capsule is loose, pinching of the ligament or synovial membrane rarely occurs, being prevented by the partial insertion of the subscapularis, supra-spinatus, and infra-spinatus muscles into the capsular ligament.

Blood Supply.—Derived from the subscapular, anterior and posterior circumflex, and suprascapular arteries.

Nerve Supply.—The shoulder-joint is supplied by the circumflex and supra-



ELBOW JOINT, — EXTERNAL VIEW.



secondary to the preceding. While the head of the radius, through its concavity, glides forward and backward during movements of the ulna, the principal function of this articulation is to allow rotation of the head of the radius in pronation and supination of the forearm.

The condyles of the humerus, which give attachment to powerful muscles of the forearm, project beyond the joint upon each side. Behind the joint is the prominence of the olecranon, into which is inserted the extensor tendon of the triceps. In front of the joint at the bottom of the antecubital fossa is found the coronoid process of the ulna, into the base of which is inserted the brachialis anticus. In the outer part of the fossa, deeply placed, is the tuberosity of the radius, into which the tendon of the biceps is inserted.

The bones are held in position by ligaments and muscles—the latter having been fully described. The ligaments consist of the external lateral, the internal lateral, an anterior, and a posterior. These are all, really, but portions of one capsular ligament which embraces the superior radio-ulnar in addition to the elbow-joint.

The **external lateral ligament** is short, and at its attachment to the external condyle, is narrow. It expands as it descends, and is attached to the orbicular ligament which surrounds the head of the radius, to the neck of the radius and to the ulna, posterior to its lesser sigmoid cavity. Its fibers are fused with the origin of the supinator brevis.

The **internal lateral ligament,** fan-shaped, is attached above by its apex to the internal condyle. Passing downward it expands and may be divided into an anterior and a posterior portion; the *anterior portion* is attached to the inner side of the coronoid process; and the *posterior* to the inner side of the olecranon. Both portions are attached to the ridge between the coronoid and olecranon processes of the ulna. It is in contact with the triceps and flexor carpi ulnaris muscles and the ulnar nerve.

The lateral ligaments are strong and tense and prevent any lateral movement. If lateral movement be possible, the joint is disorganized by disease, usually tubercular; or a dislocation exists.

The **anterior ligament** extends across the front of the joint. It is attached to

portion of the former muscle, the subanconeus, supports and draws up the thin posterior ligament during extension of the joint and prevents pinching of the synovial membrane.

The **synovial membrane** lines the joint surface of the ligaments, and is reflected upon the margins of the articulating surfaces of the bones which enter into the formation of the joint. It is continuous with the synovial sac of the superior radio-ulnar joint. There is more or less adipose tissue between the capsule of the joint and the synovial membrane where the latter is reflected from the ligaments to and upon the margins of the articulating surfaces, especially at the radial, coronoid, and olecranon fossæ.

Bursæ near the elbow-joint.—There is a small bursa over the head of the radius between the common extensor tendon of origin and the capsule; one between the tendon of the triceps and part of the upper surface of the olecranon process; one between the tendon of the biceps and the anterior portion of the tuberosity of the radius, and one in the subcutaneous tissue over the olecranon. None of these bursæ communicates with the joint.

In **acute synovitis** of the elbow-joint the synovial sac is distended with fluid, and instead of a depression on either side of the olecranon and tendon of the triceps there is a swelling with an intermediate depression which in position corresponds to the above-mentioned tendon and olecranon process.

Movements.—The movements of the elbow-joint consist only of flexion and extension; flexion is checked by the contact of the soft parts of the forearm and arm; extension by the tightening of the ligamentous and muscular structures on the anterior aspect of the joint. It must not be forgotten that the movements of the upper radio-ulnar articulation are entirely independent of those of the elbow-joint. The motion of the elbow-joint is purely a hinge movement, while that of the superior radio-ulnar joint is rotatory. In flexion and extension of the forearm the head of the radius simply glides forward and backward upon the capitellum; in supination and pronation the head of the radius has a rotatory

PLATE LXII.

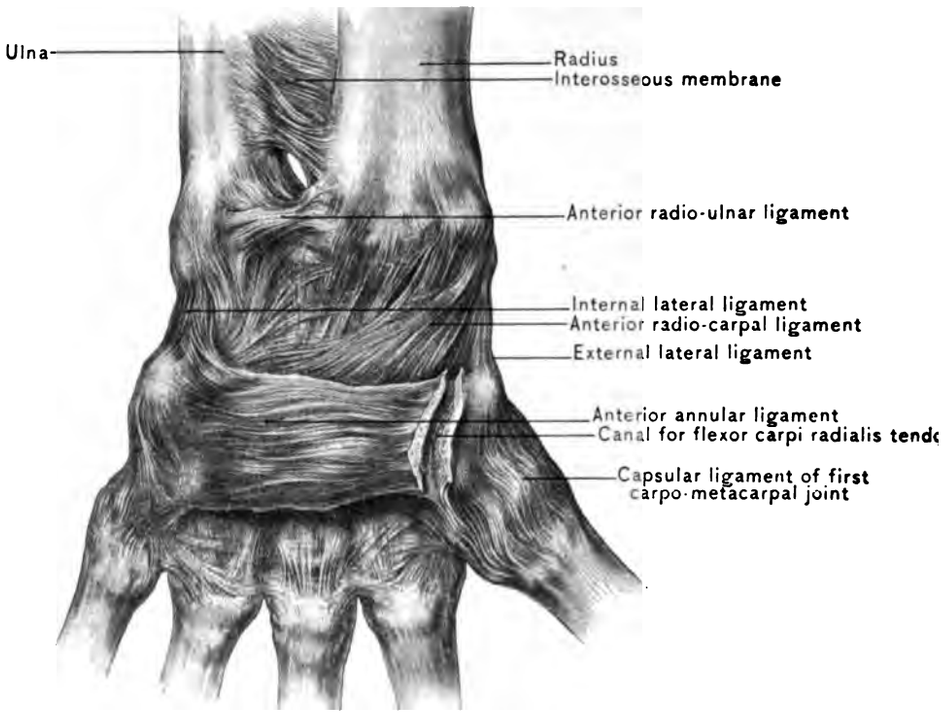
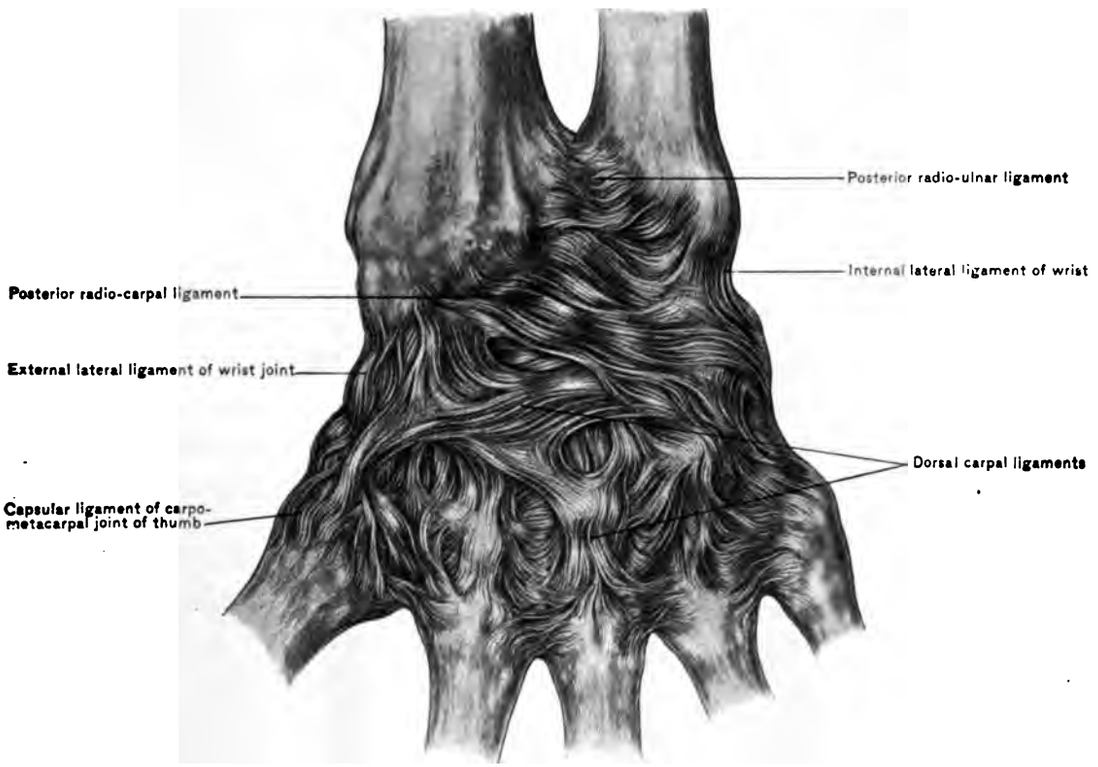

Ulna
Radius
Interosseous membrane
Anterior radio-ulnar ligament
Internal lateral ligament
Anterior radio-carpal ligament
External lateral ligament
Anterior annular ligament
Canal for flexor carpi radialis tend
Capsular ligament of first
carpo-metacarpal joint

PLATE L


Posterior radio-ulnar ligament
Internal lateral ligament of wrist
Posterior radio-carpal ligament
External lateral ligament of wrist joint
Dorsal carpal ligaments
Capsular ligament of carpo-metacarpal joint of thumb

RADIO-ULNAR ARTICULATIONS.

The movements of both pronation and supination of the forearm are possible through the articulations between the radius and the ulna. These bones may be said to form two joints, a superior and an inferior; and to be connected in three places, at the superior and inferior articulations and throughout the length of their shafts.

The **Superior Radio-ulnar Articulation,** a pivot-joint, is formed by the reception of the head of the radius into the lesser sigmoid cavity of the ulna. But one ligament, the *orbicular,* is found at this joint. It encircles the head of the radius in the form of a complete ring, as it passes from the anterior to the posterior border of the lesser sigmoid cavity. It also suspends the head of the radius, as its lower circumference is less than its upper, and it is therefore funnel-shaped. It is intimately blended with the anterior, posterior, and external lateral ligaments of the elbow-joint. The supinator brevis muscle is afforded a partial origin from this ligament.

The **synovial membrane** of this articulation is continuous with that of the elbow-joint.

Blood and Nerve Supply.—Derived from the same sources as those of the elbow-joint.

The **Inferior Radio-ulnar Articulation,** a lateral hinge-joint, is formed by the reception of the head (lower end) of the ulna into the sigmoid cavity situated on the inner side of the base of the radius. A thin layer of cartilage covers the articular surfaces of the bones. The ligaments of the joint are the anterior and posterior radio-ulnar and the triangular fibro-cartilage.

The **anterior radio-ulnar ligament** is narrow, and passes from the anterior border of the sigmoid cavity of the radius to the front of the head of the ulna.

The **posterior radio-ulnar ligament** is similarly attached to the back of the joint.

The **triangular fibro-cartilage** separates the head of the ulna from the cuneiform bone and the sigmoid cavity of the radius. It is attached, by its apex, to the depression at the base of the styloid process of the ulna, and by

is an abnormal projection of the head of the ulna, a condition frequently encountered as a complication and sequel of Colles' fracture.

The **synovial membrane** of this joint is so loose that it has been aptly called the sacciform membrane; this laxity is necessary to permit the rotation of the base of the radius about the head of the ulna during pronation and supination. The triangular fibro-cartilage follows the base of the radius in its movements around the head of the ulna.

BLOOD SUPPLY.—The nourishment of the joint is derived from the anterior interosseous artery and the anterior carpal arch.

NERVE SUPPLY.—From the anterior and posterior interosseous nerves.

The shafts of the radius and ulna are also connected by the oblique ligament and the interosseous membrane.

The **oblique ligament,** often absent, is a round slip which passes from the outer part of the coronoid process of the ulna to the radius below the tuberosity. Its direction is downward and outward. It lies above the upper border of the interosseous membrane, its fibers running in a direction at a right angle to those of the membrane.

The **interosseous membrane** is attached to the interosseous borders of the radius and ulna, and stretches across the interval existing between these bones. It is deficient above. The anterior interosseous vessels pass through an opening located near the lower end of this membrane to reach the back of the forearm. The posterior interosseous artery passes between the upper border of the interosseous membrane and the oblique ligament to the back of the forearm. The interosseous membrane helps hold the bones together, and in front gives a greater surface for the origin of the flexor profundus digitorum and the flexor longus pollicis muscle, and behind for the origin of the three extensors of the thumb and the extensor indicis.

THE RADIO-CARPAL ARTICULATION.

The **radio-carpal,** or wrist, a double ginglymus or hinge-joint, is formed above by the lower end of the radius and the under surface of the triangular fibro-cartilage, and below by the scaphoid, semilunar, and cuneiform bones of the carpus. The ulna does not enter into the formation of the joint, as it is separated from it by the triangular fibro-cartilage. The lower end of the radius, with the triangular

PLATE L)

Anterior radio-ulnar ligament
Interosseous membrane
Anterior radio-carpal ligament
Capsular ligament
Anterior intercarpal ligaments
Anterior carpo-metacarpal ligament

The **external lateral ligament** (external radio-carpal) extends from the tip of the styloid process of the radius to the outer side of the scaphoid. A few of its fibers radiate slightly to the tubercle of the scaphoid and the ridge of the trapezium, while others pass to the dorsal surface of the scaphoid. The external lateral ligament is in relation with the radial artery and the tendons of the extensores ossis metacarpi pollicis and primi internodii pollicis; the artery lies between the tendons and the ligament.

The **internal lateral ligament** (ulno-carpal) extends from the extremity of the styloid process of the ulna to the inner surface of the cuneiform bone, the pisiform bone, and the anterior annular ligament. It is fan-shaped, its fibers radiating to a more marked degree than do those of the external lateral ligament. The lower part of the ligament can readily be divided into two fasciculi, one of which passes to the inner side of the cuneiform bone, the other to the pisiform bone and anterior annular ligament.

The tendon of the extensor carpi ulnaris passes over the posterior part of the ligament.

The **anterior ligament** (anterior radio-carpal) is a broad, thick membrane which is attached above to the lower end of the radius, its styloid process, the triangular fibro-cartilage, and ulna; and below to the palmar surface of the scaphoid, semilunar, and cuneiform bones. A few of the fibers are continued downward to the os magnum and unciform bones. In relation with the anterior surface of the ligament are the tendons of the flexor profundus digitorum and flexor longus pollicis, while in contact with the posterior surface is the synovial membrane of the joint. Numerous small vessels pierce the ligament.

The **posterior ligament** (posterior radio-carpal), not so strong as the anterior, extends from the posterior surface of the lower end of the radius and triangular fibro-cartilage to the posterior surface of the scaphoid, semilunar, and cuneiform bones. It is strengthened by fibers from the back of the fibro-cartilage, and also by the fibrous sheaths of the extensor secundi internodii pollicis and radial extensors. The other extensor tendons, which are in relation with the posterior surface of the ligament, also add to its strength. The anterior surface is in relation with the synovial membrane.

The **synovial membrane** lines the ligaments of the joint from which it is reflected to the margins of the articular surfaces entering into the formation of the joint. It is very lax on account of the free movement of the joint. It does

ficial, heat and redness are also present. Swelling is most pronounced on the dorsal surface as the subcutaneous tissue is more loosely arranged in that location, and there may be bulging between the extensor tendons. Acute synovitis is differentiated from teno-synovitis, or inflammation of the sheaths of the tendons, by the fact that when the wrist-joint is fixed the fingers can, in the former condition, be moved without producing pain, and if a teno-synovitis exists, movement of the fingers causes pain.

In front of the wrist-joint are the flexor tendons of the hand, and behind are the extensors. The numerous tendons which pass over the wrist-joint, and the fibrous extensions from their sheaths, serve to strengthen an otherwise ill protected articulation.

MOVEMENTS.—The movements of the wrist-joint are very similar to those of a ball-and-socket joint, the main difference being that the wrist does not possess rotation. This loss of rotation is overcome by the pronation and supination of the forearm, which is effected by means of the radio-ulnar articulations.

BLOOD SUPPLY.—Derived from the anterior and posterior carpal arches, the anterior and posterior interosseous, and the recurrent carpal branches of the deep palmar arch.

NERVE SUPPLY.—Derived from the ulnar and the posterior interosseous nerves.

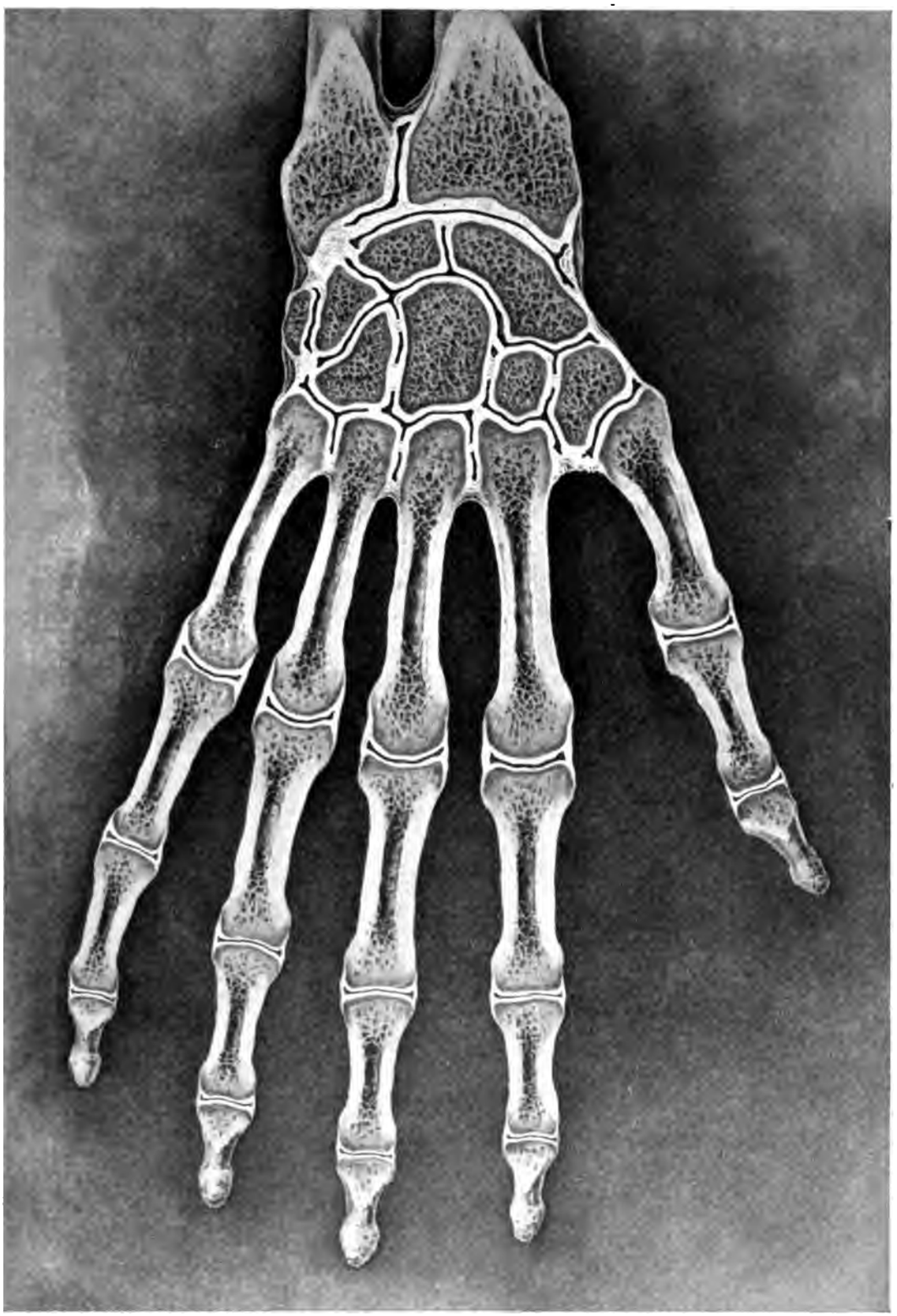
DISSECTION.—To expose the articular surfaces of the joint, cut the anterior and lateral ligaments transversely and strongly extend the hand.

THE CARPAL JOINTS.

The articulations of the bones of the carpus are divided into three sets—viz., those between the bones of the first row, those between the bones of the second row, and the articulation between the two rows. The ligaments of the first row of carpal bones are two dorsal, two palmar, two interosseous fibro-cartilages, and the capsular ligament connecting the pisiform and cuneiform bones.

The two dorsal ligaments connect the dorsal surfaces of the bones—the

PLATE L



This articulation has a separate synovial membrane. The pisiform is also attached to the unciform by a strong palmar band,—the *piso-uncinate ligament*,—and to the base of the fifth metacarpal bone by another strong palmar band—the *piso-metacarpal ligament*. These palmar bands might be regarded as prolongations from the tendon of the flexor carpi ulnaris; and the pisiform as a sesamoid bone in that tendon.

The **synovial membrane** is an extension of that lining the joint between the first and second rows of carpal bones.

The ligaments of the second row of carpal bones are three dorsal, three palmar, and two interosseous.

The **three dorsal ligaments** connect the dorsal surfaces of the bones of the second row—the trapezium with the trapezoid, the trapezoid with the os magnum, and the os magnum with the unciform.

The **three palmar ligaments** connect the palmar surfaces of the bones of the second row in the same manner as do the dorsal ligaments. The palmar ligaments are stronger than the dorsal.

The **two interosseous ligaments** connect the unciform with the os magnum, and the os magnum with the trapezoid. At times there is a third interosseous ligament found between the trapezium and the trapezoid.

The **synovial membrane** is an extension of that lining the joint between the first and second rows or the medio-carpal joint.

The **Medio-carpal Articulation** is formed by the union of the two rows of carpal bones. The line of articulation is composed of three distinct parts—on the outer side the scaphoid of the first row articulates with the trapezium and the trapezoid of the second row; in the middle the scaphoid and the semilunar of the first row form a cup-shaped cavity into which the head of the os magnum and the superior margin of the unciform of the second row are received; on the inner side the cuneiform of the first row articulates with the unciform of the second. The two rows of the carpus are held in place by four ligaments—the anterior medio-carpal, the posterior medio-carpal, the internal lateral, and the external lateral.

The **anterior medio-carpal ligament** connects the palmar surfaces of the bones of the first row with those of the second. Most of the fibers extend from the first row to the os magnum, others connect the scaphoid to the trapezium and the trapezoid, while the remaining ones pass from the cuneiform to the unciform.

The **posterior medio-carpal ligament** consists of fibers which pass obliquely

The **external lateral ligament** connects the scaphoid with the trapezium.

The **internal lateral ligament** connects the cuneiform with the unciform.

The **synovial membrane** of the carpus lines the medio-carpal joint, and sends two prolongations upward between the scaphoid and semilunar and the semilunar and cuneiform bones. It sends downward three extensions which line the joints of the second row, the carpo-metacarpal joints of the four inner metacarpal bones, and the joints between the bases of these metacarpal bones.

MOVEMENTS of the carpal joints are limited, to a great extent, to the motions of flexion and extension. There is allowed a gliding motion which is antero-posterior, and a very slight degree of rotation between the articulation of the os magnum with the scaphoid and the semilunar.

BLOOD SUPPLY.—The carpal articulations are nourished by the anterior and posterior carpal branches of the radial and ulnar arteries, by the anterior interosseous, and the recurrent carpal branches of the deep palmar arch.

NERVE SUPPLY.—Derived from the ulnar, the median, and the posterior interosseous nerve.

DISSECTION.—To expose the articulating surfaces of the medio-carpal joint and the interosseous ligaments divide the dorsal and lateral ligaments and strongly flex the hand.

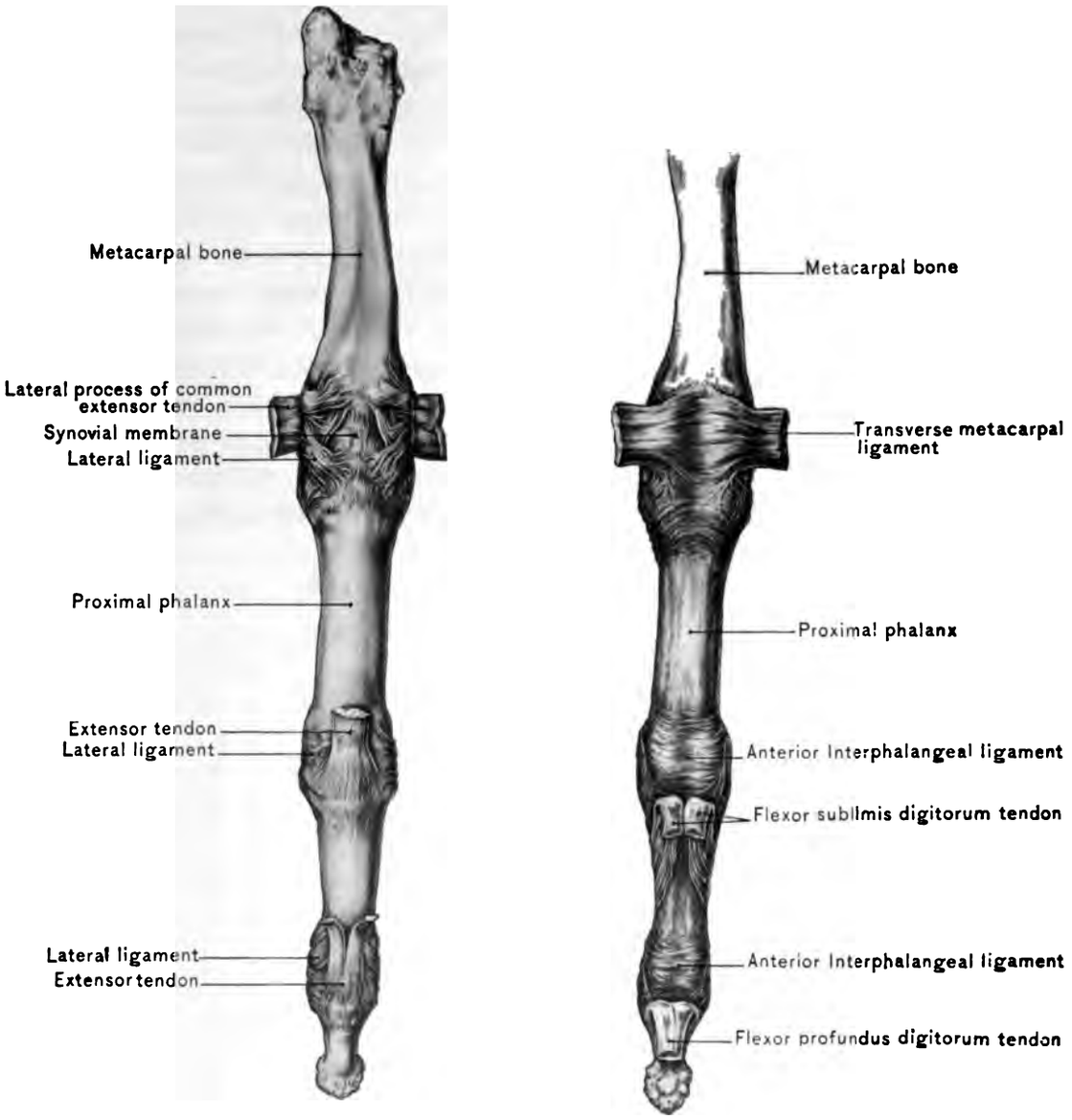
CARPO-METACARPAL ARTICULATIONS.

The articulations between the carpal and metacarpal bones may be divided into two sets—the junction of the four inner metacarpal bones with the unciform, os magnum, and trapezoid; and the articulation of the metacarpal bone of the thumb with the trapezium.

In the **First Set** the metacarpal bone of the index finger articulates with the trapezoid, that of the middle finger with the os magnum, and the ring and little fingers with the unciform. The ligaments connecting the bones are dorsal, palmar, and interosseous.

The **dorsal ligaments** are stronger and more distinct than the palmar. They connect the dorsal surface of the respective carpal bones with the dorsal surface of the metacarpal bones. The metacarpal bone of the index finger has two fasciculi—one from the trapezium, the other from the trapezoid; that of the middle finger has two—one from the trapezoid and one from the os magnum;

PLATE LXVI.


Metacarpal bone
Lateral process of common extensor tendon
Synovial membrane
Lateral ligament
Proximal phalanx
Extensor tendon
Lateral ligament
Lateral ligament
Extensor tendon
Metacarpal bone
Transverse metacarpal ligament
Proximal phalanx
Anterior Interphalangeal ligament
Flexor sublimis digitorum tendon
Anterior Interphalangeal ligament
Flexor profundus digitorum tendon

magnum, one from the trapezium, and a third from the unciform and the base of the fifth metacarpal; the ring and little fingers have one each—from the unciform.

The **interosseous ligament** is found only in one part of the joint. It connects the adjacent angles of the unciform and os magnum with the metacarpal bones of the middle and ring fingers.

The **synovial membrane** is a continuation of that lining the medio-carpal joint. At times there is a separate synovial lining for the articulation of the unciform with the fourth and fifth metacarpal bones.

BLOOD SUPPLY.—The carpo-metacarpal joint of the index finger is nourished by the radial, the metacarpal, the dorsalis indicis, and the radialis indicis artery; of the middle and ring fingers, by the anterior and posterior carpal arches and the deep palmar arch; of the little finger, by the ulnar artery and its deep branch and, also, the posterior carpal arch.

NERVE SUPPLY.—From the deep palmar branch of the ulnar, from the median and posterior interosseous nerves.

The **Second Set** consists of the articulation between the metacarpal bone of the thumb and the trapezium. But one ligament, the capsular, connects these bones.

The **ligament** is a loose capsule which extends from the margin of the articular surface of the trapezium to that of the metacarpal bone. It is stronger on its dorsal aspect.

The **synovial membrane** is separate from that of the carpal and the other carpo-metacarpal joints.

MOVEMENTS of the carpo-metacarpal joint of the four inner metacarpal bones are slight; that of the little finger is most free, followed by that of the ring finger. The articulations of the index and middle fingers are almost immovable. The carpo-metacarpal joint of the thumb is allowed the greatest freedom of motion by the shape of the articulating surfaces of the bones.

BLOOD SUPPLY.—This joint is nourished by the radial, dorsalis pollicis, and princeps pollicis arteries.

NERVE SUPPLY.—From the median nerve.

The **interosseous ligaments** pass between the lower margins of the adjacent articulating surfaces.

The **synovial membranes** of these joints are extensions of the common carpal synovial membrane.

BLOOD SUPPLY.—From twigs of the palmar and dorsal interosseous arteries.

NERVE SUPPLY.—From the ulnar and posterior interosseous nerves.

The distal extremities or heads of the four inner metacarpal bones are held in place by the **transverse ligament,** which is situated on the anterior or palmar surface. It is a fibrous band consisting of three fasciculi, which connect the second and third, the third and fourth, and the fourth and fifth bones. It blends with the glenoid ligament of the metacarpo-phalangeal articulations. The interosseous muscles pass behind it to reach their points of insertion, while the digital arteries and nerves and flexor tendons and lumbrical muscles pass in front of it.

The Metacarpo-phalangeal Articulations.—The head of each metacarpal bone is received into a cup-shaped cavity on the proximal end or base of the corresponding phalanx. They are held in place by an anterior (glenoid) and two lateral ligaments.

The **anterior (glenoid) ligament** is a dense, fibrous plate which is firmly attached to the base of the first phalanx and loosely attached, by areolar tissue, to the head of the metacarpal bone. It deepens the articular surface of the base of the phalanx. Its margins are continuous with the lateral ligament, the transverse metacarpal ligament, and the fibrous sheath of the flexor tendon.

The **lateral ligaments** are strong short bands, situated on either side of the joint, that connect the tubercle and depression on the side of the head of the metacarpal bone to the base of the phalanx. Anteriorly they are continuous with the anterior ligament and, posteriorly, with the expansion of the extensor tendon.

The **synovial membrane** is very loose.

The posterior surface of the joint is covered by an expansion of the extensor

for sesamoid bones. The ligaments are two lateral and a posterior. The *lateral* ligaments are short, fibrous bands which connect the adjacent ends of the articulating bones. The *posterior* ligament passes across the joint and connects the two lateral ligaments.

The **sesamoid bones,** two in number, rest on the facets on the head of the metacarpal bone of the thumb, in the tendons of the flexor brevis pollicis. They are connected by transverse fibers which cover the front of the joint.

BLOOD SUPPLY.—Derived from the princeps pollicis and dorsales pollicis.

NERVE SUPPLY.—Derived from the digital branches of the median and radial nerves.

THE INTERPHALANGEAL ARTICULATIONS.

The ligaments of the interphalangeal articulations consist of an anterior (glenoid) and two lateral.

The **anterior (glenoid),** like that of the metacarpo-phalangeal joint, is loosely attached to the proximal bone, but very firmly to the distal. It blends with the lateral ligaments. The flexor tendons pass over the anterior ligament.

The **two lateral ligaments** are strong bands which connect the sides of the proximal phalanx with the lateral aspect of the distal phalanx.

Posteriorly, the extensor tendon covers the joint and takes the place of a posterior ligament. The tendon blends with the lateral ligaments to complete the capsule around the joint.

The **synovial membranes** of these joints are lax.

MOVEMENTS of the interphalangeal joints are limited to extension and flexion; flexion being much more free than extension. Lateral movement is prevented by tenseness of the lateral ligaments.

BLOOD SUPPLY.—Derived from the collateral digital arteries.

NERVE SUPPLY.—From the collateral digital nerves.

DISLOCATIONS.

It has been shown, in the description of the ligaments of the various joints, that the bones forming the articulations are so firmly held in place that it is almost impossible to have a luxation, or dislocation, without tearing one or more of the ligaments. At times the tissues surrounding the joint may become so lax and so stretched that without rupture of any of the ligaments they will allow a displacement of the bones composing the joint. The muscles play a very important part

in the reduction of luxations. By manipulating the dislocated member so that the muscles will have an opportunity to return to their normal condition from the overstretched state caused by the luxation, the displaced member can, more easily, be reduced.

Dislocations should be reduced as soon after the injury as possible, because after swelling and inflammation have developed reduction is more difficult, and early reduction lessens the probability of subsequent disability.

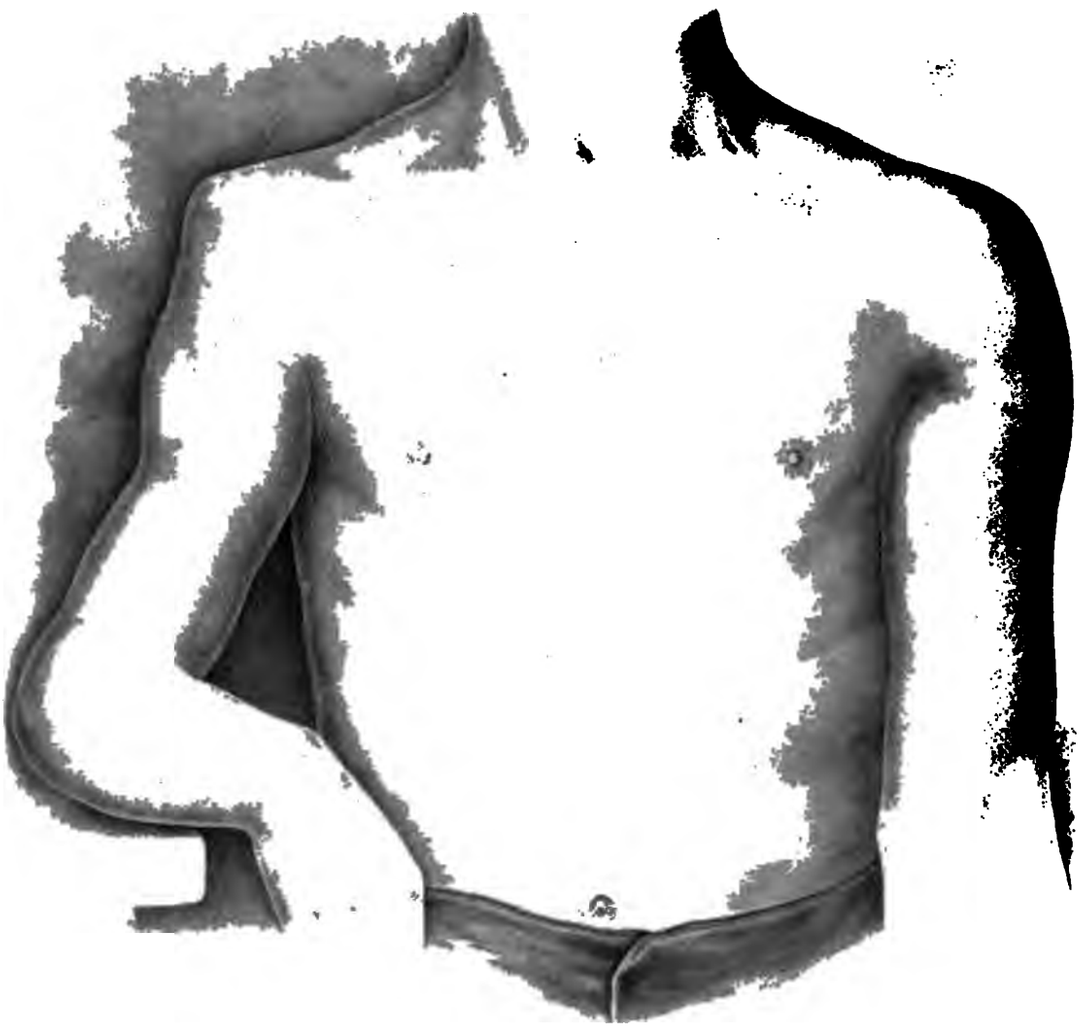
The **clavicle may be dislocated** at either end. Luxations at the sternal end may be forward, forward and upward, forward and downward, or upward. A backward displacement is rarely, if ever, seen. In complete luxation of the sterno-clavicular joint it is probable that the anterior and posterior sterno-clavicular and the interclavicular ligament will be ruptured. The costo-clavicular ligament will also suffer to a greater or less extent. The interarticular fibro-cartilage may remain attached to either of the bones.

Dislocation of the clavicle at the acromial end is much more frequent than at the sternal end. In most cases there is but a partial dislocation. The capsular ligament formed by the superior and inferior acromio-clavicular ligaments is torn, while the conoid and trapezoid ligaments remain intact but are stretched. In complete luxation the conoid and trapezoid ligaments are more or less torn. The trapezius muscle then tends to pull the distal end of the clavicle upward, section of the fibers of the trapezius often being required to allow reduction to be maintained.

Dislocations of the humerus are very frequent, owing to the great freedom of motion at the shoulder, the exposed position of the joint, and because the joint depends for its strength chiefly upon the elasticity and tonic contraction of the surrounding muscles; consequently, when the muscles are relaxed and force is suddenly applied to the joint directly by a blow upon the shoulder, or indirectly by a fall upon the hand or elbow, the head of the humerus slips out of the glenoid cavity. Four varieties are usually described: Three anterior—subcoracoid, subglenoid, and subclavicular; and one posterior—the subspinous.

In the *subglenoid luxation* the head of the humerus makes its escape from the glenoid cavity by tearing through the lower part of the capsular ligament. The head of the humerus is then found in the axilla, resting upon the triangular part of the axillary border of the scapula, immediately below and a little in front of the glenoid cavity and between the tendon of the subscapularis and that of the long head of the triceps muscle. The superior part of the capsule is tightly stretched across the glenoid cavity. In many cases the tendon of the long head of the biceps will be torn. The muscles attached to the tuberosities of the humerus

PLATE LXVII.



stretched or lacerated; the infraspinatus, subscapularis, and coraco-brachialis are generally put on the stretch; the deltoid muscle is in extreme tension and draws the elbow away from the body; the teres major and the teres minor are relaxed. The rotundity of the shoulder is lost, and a flatness is present owing to the displacement of the greater tuberosity, which allows an undue prominence of the acromion process to exist and causes the formation of a transverse depression below it. The circumflex nerve, which curves over the lower margin of the subscapularis muscle and around the surgical neck of the humerus is liable to injury, producing paralysis of the deltoid. Atrophy of the deltoid is caused by disuse, as in ankylosis of the shoulder-joint; more frequently by diseases of the spinal cord, as acute anterior polio-myelitis; by ascending neuritis of the circumflex nerve usually due to disease of the shoulder-joint and causing paralysis of the muscles; and by injury of the circumflex nerve by a blow or fracture of the upper part of the humerus. On account of the relation of the contents of the axilla to the head of the dislocated humerus there may be injury to the nerves and vessels of this space; the axillary artery or vein may be ruptured; the brachial plexus of nerves has been stretched so much that a partial paralysis followed the dislocation. This dislocation and fracture of the anatomic neck of the scapula are the only injuries about the shoulder in which the arm is lengthened.

In the *subcoracoid*, the most frequent luxation, the head of the bone escapes through a tear in the anterior part of the capsule, and rests below the coracoid process upon the anterior surface of the neck of the scapula. There is, generally, injury to the coraco-brachialis and the short head of the biceps, the conjoined tendon of origin of which muscles will be found to rest on the anterior surface of the head of the bone.

In the *subclavicular luxation* the head of the bone escapes through a tear in the anterior portion of the capsule, and rests below the clavicle against the chest, beneath the pectoralis major and minor muscles. In both the subcoracoid and subclavicular luxations the deltoid is greatly stretched, and the subscapularis is carried upward, with occasional rupture of its attachment to the lesser tuberosity of the humerus. The infra-spinatus and supra-spinatus muscles are stretched and, at times, lacerated. The vessels and nerves of the axilla are carried forward with

of the capsule, below the spine of the scapula and beneath the infra-spinatus muscle. The infra-spinatus will be relaxed, but the supra-spinatus and sub-scapularis stretched or torn. The tendon of the long head of the biceps and the anterior fibers of the deltoid will be stretched, but not ruptured.

In all the *luxations of the head* of the humerus the *rotundity* of the shoulder will be lost, and *flattening* present, owing to the displacement of the greater tuberosity; a depression will be seen where the greater tuberosity is normally found. The head of the bone will be found as a swelling in the location to which it has been displaced. Flattening of the shoulder in dislocation of the shoulder-joint must not be mistaken for atrophy of the deltoid muscle. In the latter condition the mobility and position of the head of the humerus and position of the tuberosities are normal.

In all the forward or anterior luxations the elbow is carried away from the body by the resultant tension of the deltoid. In the subspinous luxation (posterior) the elbow is carried forward and to the side of the body by the pectoralis major and coraco-brachialis muscles. In the reduction of shoulder-joint dislocations the axillary vein or artery may be injured, as may also the nerves in this locality; therefore, great care must be observed to avoid such an accident, especially if the lesion has existed for any time prior to treatment. The condition of the axillary artery should be determined. If the artery is atheromatous or included in dense connective tissue, formed during the associated inflammation, it may be ruptured in the attempt at reduction. The vessel which is more commonly ruptured, however, is the axillary vein. Fixation of the scapula is an important adjuvant in the reduction of dislocations of the humerus.

Dislocations at the elbow-joint may involve both the radius and ulna, or

process of the ulna rests in the olecranon fossa of the humerus, and the head of the radius lies behind the external humeral condyle. The bones are pulled upward by the triceps muscle. The articulating surface of the humerus can be plainly felt in front of the elbow. The posterior and orbicular ligaments do not suffer injury, while the anterior and the two lateral ligaments will be ruptured. The tendon of the biceps is pulled backward over the articulating surface of the humerus, and, while tense, is seldom ruptured. The brachialis anticus will be forcibly stretched. The ulnar nerve may be painfully stretched, on account of its being carried backward with the ulna. The median nerve, together with the ulnar and interosseous vessels, suffers from the pressure of the projecting humerus.

Simple *forward dislocation* of the radius and ulna has been said by many surgeons to be impossible. They contend that it is necessary to have a fracture of the olecranon process of the ulna in order to allow the bones to slip forward. This variety of luxation is rare. The forearm is elongated on account of the added length of the olecranon process, which slips forward and rests in front of the trochlear surface of the humerus. There will be a depression in front, corresponding to the greater sigmoid cavity of the ulna. The trochlear surface of the humerus will be plainly felt posteriorly, with the tendon of the triceps tightly stretched over it, unless this structure has been ruptured. The humeral condyles will be very prominent. The posterior ligament will be ruptured and the lateral ligaments will be in extreme tension. When the dislocation is more complete, the olecranon process of the ulna rests in front of the internal condyle of the humerus, and the head of the radius in the coronoid depression of the humerus.

In both the backward and forward luxations of the radius and ulna the olecranon process and the external and internal condyles are not in line.

The elbow-joint is most readily dislocated backward when the joint is in incomplete extension, for in this position the coronoid process offers less resistance to backward movement of the upper end of the ulna, and the olecranon is not engaged in the olecranon fossa. Forward luxation is most likely to occur when the joint is incompletely flexed, as in this position the olecranon process of the ulna less firmly grasps the humerus, and the coronoid process is not engaged in the coronoid depression of the humerus.

Dislocations forward or backward are more common than lateral luxations.

is somewhat elevated, thus making it necessary for the ulna to ascend an inclined plane. This also accounts for the infrequent occurrence of this luxation. The median ridge of the greater sigmoid cavity of the ulna is forced over the inclined plane of the trochlea. The outer part of the sigmoid cavity rests on the inner margin of the trochlea or below the internal condyle. The head of the radius is forced inward and rests against the trochlear space which is normally occupied by the sigmoid cavity of the ulna. The ulnar nerve is forcibly stretched; this may be the cause of intense suffering. The internal lateral ligament is almost always ruptured, while the external lateral, the orbicular, the anterior, and the posterior ligament are put on the stretch.

Outward luxation of both bones is more frequent than inward luxation, on account of the inclined plane formed by the elevated inner side of the trochlear surface of the humerus. The dislocation is generally incomplete, although there are on record cases of complete outward luxation of both bones. In partial outward dislocation the inner part of the sigmoid cavity will rest on the external condyle of the humerus, or the crest of the sigmoid cavity will occupy the depression between the trochlear surface and the radial head of the humerus. In complete outward dislocation the coronoid process, the olecranon process, and the greater sigmoid cavity of the ulna will be plainly felt lying to the radial side of the humerus. The internal condyle of the humerus will be very prominent. The head of the radius will remain in its normal relation to the ulna, if the orbicular ligament remains intact, or it may be carried forward or backward, if that ligament be ruptured. All of the ligaments of the elbow-joint will be stretched, and some probably torn. The fibers of the brachialis anticus and anconeus muscles may be lacerated. The tendons of the biceps and triceps will not be injured, but will hold a more oblique position.

The **head of the radius** may be dislocated forward, forward and outward, and backward. The last-named dislocation is very rare.

In the *forward luxation*, the most common, the head of the radius is generally found upon the front of the humerus. The anterior and external lateral ligaments are more or less torn, and the orbicular ligament is either lacerated or so stretched

Dislocation of the upper end of the ulna alone is very rare. It is almost always associated with dislocation of the radius, or with fracture of some of the neighboring bony prominences. The anatomy is similar to that found in luxation of both bones, with the exception that the orbicular ligament is always torn, but the head of the radius holds its normal relation to the capitellum of the humerus.

Dislocations of the radio-carpal joint are very rare. When they do occur, they are, generally, complicated by fracture of the radius or the styloid process of the ulna. Cases of simple luxation of the joint, either backward or forward, do occur.

In the *backward luxation* the posterior and lateral ligaments are torn; the anterior ligament may remain intact, although it is often lacerated. The extensor muscles will probably be found to be torn from the bones in the lower part of the forearm, and also displaced. The nerves and arteries, in relation with the joint, are usually displaced or ruptured. The radius and ulna will present anteriorly, while the first row of carpal bones will lie behind the bones of the forearm and beneath the extensor tendons. If the luxation be compound, as it frequently is, there will be laceration of the tendons which cross the joint.

If the carpus be *displaced forward*, the reverse position of the various bones will be held, and the flexor tendons lacerated and displaced. The anterior ligament will be ruptured. In both luxations the forearm is shortened. In the backward luxation the hand is flexed, while in the forward it is extended.

In the diagnosis of dislocation of the wrist-joint the relation of the metacarpal bone of the thumb to the styloid process of the radius should be observed. If this relation be normal, no dislocation of this joint can be present.

The **lower end of the ulna** may be dislocated either backward or forward; this accident, uncomplicated, is rather rare. The posterior radio-ulnar and the internal lateral ligament of the wrist-joint are torn in the backward luxation, and the triangular fibro-cartilage is detached from the ulna. The head of the ulna is forced out of its socket and lies across the lower end of the radius. In the forward

as a complication. The fact that they are so firmly held in place by the anterior annular ligament and their own ligaments, as well as by the flexor and extensor tendons, will show why this accident is so rare.

Dislocations of the phalanges are frequent occurrences, and often lead to permanent deformity.

Dislocation of the proximal phalanx of the thumb is an accident often seen, and is, at times, one of the most difficult to reduce. It may occur either as a backward or a forward luxation, the former being the more frequent.

In the *backward luxation* the proximal end of the phalanx will present on the dorsum of the metacarpal bone of the thumb, and the head of the latter bone will form a distinct projection on the palmar surface of the thumb. The anterior ligament is torn and lies in front of or upon the head of the metacarpal bone; the lateral ligaments may or may not be lacerated; the tendon of the flexor longus pollicis is displaced to the ulnar side of the head of the metacarpal bone. Many reasons have been advanced to explain the frequent difficulty in reduction of this dislocation; some of these reasons are that the neck of the metacarpal bone is held between the two tendons of the flexor brevis pollicis; that the muscles of the thumb are so strong that it is almost impossible to overcome them; and that the neck of the metacarpal bone is held between the lateral ligaments. Interposition of the anterior ligament and other parts of the capsule between the articular ends of the bones is regarded by many surgeons as offering the chief obstacle to reduction of this dislocation.

Forward luxation of the proximal phalanx of the thumb is not very common. The base of the phalanx will present anteriorly, with the head of the metacarpal bone resting upon its dorsum. The lateral and anterior ligaments will either sustain severe stretching or be torn. This luxation is more readily reduced than the backward variety.

In dislocation of the various phalanges of the fingers the lateral ligaments will always be stretched and possibly torn; the anterior ligament may be lacerated,

layer of cancellous bone tissue. The central portion of the shaft, throughout the greater part of its length, is occupied by the marrow which fills the medullary canal. When a bone is fractured, some of the fat globules of the marrow may enter torn veins, held open by their adherence to the walls of the bony channels, and cause fat embolism. In the extremities of the bones the whole thickness of the bone internal to the compact bone is occupied by cancellous tissue. The shaft receives its nourishment from the periosteum and from the nutrient artery which passes into the marrow; the extremities are nourished by the periosteum and the articular arteries. When, in an amputation, a bone is divided above the point of entrance of the nutrient artery, the stump of the bone is supplied with nutrition through the periosteum and articular arteries.

The *periosteum* is a fibrous membrane which invests the bones at all parts, except those portions which are covered by articular cartilage and give attachment to large tendons. It carries the blood-vessels which nourish the external portion of the bone. The cells next to the bone (osteoblasts) are capable of forming new bone, therefore the deeper portion is called the *osteo-genetic layer* of the membrane. The outer layer is composed of fibrous and elastic tissue, arranged chiefly in a longitudinal direction. In raising flaps of periosteum it is well, on account of the longitudinal direction of the fibers, to make both longitudinal and transverse incisions into that membrane, so that it will not split and be stripped from the bone for some distance.

It has been demonstrated that the *growth of a bone* occurs in three ways: (1) By means of the osteo-genetic layer of the periosteum; (2) through the epiphyseal cartilage; and (3) through interstitial deposit or deposit by the osteoblasts in the Haversian systems. By means of the periosteum and interstitial deposit the bone grows in thickness; through the epiphyseal cartilage and interstitial deposit, in length.

A *bone increases in thickness* chiefly through the osteo-genetic layer of the periosteum and partly by interstitial deposit, and *in length* chiefly through the ossification of successively developed layers of cells of the epiphyseal cartilage which connects the shaft with the extremities, and to some extent by interstitial deposit. Therefore, in amputations through bones in young persons the periosteum should not be stripped back by pulling upon the flaps when the bone is divided, and the epiphyseal cartilage should be left intact in excisions of joints. As a result of disease or injury of the epiphyseal cartilage the epiphysis sometimes unites with the shaft, and the corresponding bone of the other side gradually becomes the

of the periosteum becomes locally active, and an exostosis develops. In acute suppurative periostitis an early incision down to the bone is required to allow the pus to escape, for if drainage is not provided, the periosteum is floated from the shaft of the bone from one epiphyseal line to the other, and the whole shaft dies or undergoes necrosis. The termination of the periosteum at the line of attachment of the ligaments, and the free and separate supply of blood to the epiphyses through the articular arteries, minimize the danger that the process will extend into the joints. This is fortunate, as involvement of the joints would probably necessitate amputation.

EXCISIONS.

Excisions may be divided into excisions of bones and excisions of joints. Bones are usually excised for ununited fracture and malignant growth, and joints for disease and injury and for the results of disease and injury. Excision of a bone implies either removal of a portion or of the whole bone. The injuries in which excision of a joint may be demanded are fractures extending into joints, especially if compound; gunshot wounds of the joint or of the articular ends of the bones entering into the joint; and compound dislocations. The disease requiring excision is usually tubercular in character. The operation is performed to shorten the length of time necessary for recovery, thereby shortening the convalescence of the patient to a few weeks instead of allowing the disease to exist for months or years with an uncertain result. Where the patient is becoming weaker as a result of pain and persistence of the disease, the operation is performed to save life. One of the results of disease or injury to relieve which excision is performed is ankylosis of the joint in a bad position. All of the diseased tissue should be removed so that a good result will be assured. In the upper extremity the best result is obtained by preserving mobility through the formation of a false joint. In the lower extremity ankylosis is more desirable than a false joint, as the latter would not give certain support to the superimposed weight.

Conditions for which excisions are done in early life require amputation later

below and then above. In stripping off the periosteum sever the attachments of the sterno-mastoid, pectoralis major, trapezius, and deltoid muscles, and the attachment of the anterior layer of the costo-coracoid membrane. Next cut through the ligaments of the acromio-clavicular articulation, superior and inferior acromio-clavicular ligaments, and the interarticular fibro-cartilage, when the acromial end of the bone should be raised and the structures attached to its under surface divided—namely, the coraco-clavicular ligament, the subclavius muscle with the posterior layer of the costo-coracoid membrane, and the costo-clavicular (rhomboid) ligament. Next detach the bone from the opposite clavicle and sternum by dividing the interclavicular ligament, the anterior and posterior sterno-clavicular ligaments, and the interarticular fibro-cartilage. In separating the clavicle from the underlying structures care must be taken to avoid injuring the subclavian vessels and brachial plexus.

In sarcomatous tumors of the clavicle there will be found many additional vessels, which make the excision more difficult. If the subclavius muscle remain intact, it may be taken as a guide to the subclavian vessels which lie beneath it.

Excision of the shoulder-joint is required for disease of the joint, caries of the head of the humerus, and disease of the cartilage. As the glenoid cavity quickly recovers after the head of the bone is excised, the glenoid fossa need not be removed. Excision may also be necessary in the treatment of injuries such as compound fracture and gunshot wounds; and sometimes the results of injury or disease require excision of the head of the humerus. Ankylosis of this joint seldom demands excision, because the weight of the arm causes fixation in the best position,—with the arm at the side,—and the mobility of the scapula largely compensates for fixation in the shoulder-joint, and the utility of the limb after excision may not be any greater than after the occurrence of ankylosis.

Excision of the shoulder.—In excision of the head of the humerus an incision is carried from the acromion process for about five inches down the arm in the line of the humerus. The incision should be made down to the bone, dividing in its course the skin, superficial fascia, twigs from the acromio-thoracic, anterior and posterior circumflex vessels, acromial branches of the cervical plexus of nerves, the deep fascia, the fibers of the deltoid muscle, and the trunk of the anterior circumflex artery and vein. The capsular ligament is opened and the supra-spinatus, infra-spinatus, and teres minor muscles severed from their attachment to the greater tuberosity, and the subscapularis from the lesser tuberosity. These muscles should be detached close to their insertions into the tuberosities. The long head of the biceps must be dissected from its groove and pushed to one side. The coraco-humeral and capsular ligaments are then divided and the head of the humerus

protruded from the glenoid cavity by carrying the arm in front of the body and pushing it upward. The diseased portion of the bone can then be removed without injury to the posterior circumflex vessels and circumflex nerve and the structures in the axilla. At times it may be necessary to detach the head of the bone from the shaft while it remains in the glenoid cavity. In such cases a broad strip of metal or horn should be passed between the neck of the bone and the axillary structures, in order to prevent injury to the latter.

Excision in the continuity of the humerus.—In excising a portion of the shaft of the humerus the incision should be made on the outer aspect of the arm, in the sulcus between the biceps in front and the triceps behind. The skin, superficial fascia, twigs of the upper and lower cutaneous branches of the circumflex nerve, twigs from the anterior and posterior circumflex and superior profunda vessels, the deep fascia, and the periosteum will be severed. The cephalic vein is avoided. The incision should be made as long as necessary, but in carrying it downward, care should be taken to keep close to the outer border of the biceps. In the lower part of the arm it is necessary to avoid the musculo-spiral nerve, which lies between the brachialis anticus and supinator longus muscles. The periosteum should be separated from the bone, and as much as necessary of the humerus removed. There will be but little bleeding.

Excision of the elbow-joint is performed for disease of that joint, as tubercular arthritis; injury, as compound dislocation, compound and comminuted fractures; and the results of disease, as ankylosis in a bad position. Ankylosis of this joint causes considerable disability; therefore, in treating disease of the joint it is most important to preserve its mobility.

Excision of the elbow.—With the forearm pronated and slightly flexed, a longitudinal incision about four inches in length is carried over the joint, the middle of the incision being directly over the olecranon process of the ulna. The incision severs the skin, superficial fascia, twigs of the inferior external cutaneous branch of the musculo-spiral nerve, twigs of the lesser internal cutaneous nerve, branches of the inferior profunda, anastomotica magna, interosseous and posterior ulnar recurrent vessels, and the deep fascia. This exposes the tendon of the triceps, which should be split longitudinally down to the bone. The outer half of the triceps, its aponeurotic expansion, and the anconeus muscle should then be carefully pushed to one side. The internal part of the triceps should next be lifted. In doing this care must be taken not to injure the ulnar nerve, which lies in the groove between the internal condyle of the humerus and the olecranon. The nerve is here covered by a dense membrane, which should be incised, when the nerve can be

the bones protruded through the wound by sharply flexing the forearm and separating the periosteum from the bones with the soft parts attached. A spatula may now be passed between the anterior surfaces of the bones and the structures in front of the elbow-joint, and as much bone removed as is necessary. If possible, it is advisable to remove only the articulating surface of the humerus, the olecranon process as low as the coronoid process, and the head and neck of the radius above the tubercle. This will allow the brachialis anticus and biceps muscles to remain intact.

After this operation for disease ankylosis is likely to occur, consequently the amount of bone removed must not be too small, and passive motion should be practised after ten days. After excision for injury a flail-like joint is a result more likely than ankylosis, and the part must be kept steady by a splint, which should have a hinge at the elbow so that passive motion may be practised without laterally moving the joint. Passive motion should at first consist merely of a change in the position of the forearm, which should be flexed during the day and extended at night. Later, the movements may be more frequently and freely performed, and supination and pronation may be practised.

Excision of the bones of the forearm.—In **excising the ulna,** or a portion thereof, the incision should be carried along the posterior or subcutaneous border of the bone, between the extensor carpi ulnaris and flexor carpi ulnaris. The skin, superficial fascia, a few small vessels and nerves, and generally the posterior branch of the internal cutaneous nerve will be severed. After incising the deep fascia, the periosteum is divided and separated from the bone as far as necessary, carrying with it the soft parts. The interosseous membrane is incised along the radial side of the bone. The bone can then be divided with bone forceps or with a metacarpal or chain saw, and removed.

In **excision of the radius,** or a part of it, the incision should be made along the outer side of the bone, between the supinator longus and the extensor carpi radialis longior, taking advantage of the position of the radial nerve in locating the interval between the tendons of the respective muscles. The skin, the superficial fascia, a few small vessels and nerves, the deep fascia, and the periosteum will

compound dislocation, or gunshot wounds. If an excision is performed for disease, it is usually necessary to remove the ends of the radius and ulna, the carpus, and the bases of the metacarpal bones, so as to include all diseased bone. Total excision of this joint, including the carpal bones and the bases of the metacarpal bones, is seldom necessary. By placing the part at rest and improving the general health the disease may usually be arrested without operation and a useful hand preserved. Passive motion of the fingers must be practised early to obtain the best possible result. In excising the wrist-joint two incisions should be made: one along the radius, extending from a point about two inches above the styloid process of the radius to the middle of the metacarpal bone of the thumb; and another along the ulna, from a point about two inches above the styloid process of the ulna to the middle of the metacarpal bone of the little finger. The radial incision severs the skin and superficial fascia, twigs of the musculo-cutaneous and radial nerves, small branches of the radial artery, some superficial veins, and the deep fascia. Great care must be taken not to injure the radial artery, which lies in front of the lower end of the radius and upon the external lateral ligament of the wrist-joint. The radial incision passes between the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis. The ulnar incision divides the skin and superficial fascia, twigs of the internal cutaneous nerve, small cutaneous branches of the ulnar artery, some superficial veins, and the deep fascia. The tendons and soft parts are to be carefully dissected from the posterior surface of the carpus, radius, and ulna. The radial artery is now displaced, and held aside with a retractor. A sharp-pointed bistoury is entered on each side in front of the radius and ulna, and the soft parts separated from both bones by carrying the knife downward. As the knife passes over the carpus it will come in contact with the pisiform bone, which lies on the ulnar side of the forearm; this bone should be removed with a pair of bone forceps. The lateral ligaments are next divided, the ulna and radius drawn out on their respective sides, and the articulating surfaces removed. A blunt-pointed bistoury is used to divide the dorsal ligaments between the two rows of carpal bones, and the upper row is removed with the sequestrum

of the middle and the index finger. The deep fascia is cut, and care must be taken to avoid injuring the extensor tendons; these must be pushed to one side, and the periosteum divided. If the head of the bone is to be removed, the metacarpo-phalangeal joint must be opened by cutting through one of the lateral expansions of the extensor tendon, raising the tendon, and dividing the lateral ligaments and the transverse metacarpal ligament; the bone is then elevated. The interosseous muscles must be separated from the bone with the periosteum, and the bone freed from all surrounding structures. As much of the metacarpal bone as is diseased can then be removed with the forceps. Care must be taken not to injure the deep palmar arch when removing the structures from the palmar surface of the bone. If the entire bone be removed, the carpo-metacarpal ligaments must be severed.

In **excision of the metacarpal bone of the thumb** the incision should be made on the line between the dorsal and palmar surfaces. Skin, fasciæ, branches of the radial artery, superficial veins, and branches of the radial nerve will be severed, yet with care the branch of the radial nerve supplying the outer side of the thumb need not be divided. The incision reaches the bone by passing along the palmar side of the tendon of the extensor primi internodii pollicis. The soft structures with the periosteum are separated from the bone on the palmar and dorsal surfaces, and the ligaments of the carpo-metacarpal and metacarpo-phalangeal joints severed.

In **excising the articulating surfaces of the phalanges** the incision should be made over the dorsal aspect of the respective joints at the side of the extensor tendon, and should extend from the proximal side of the joint to the middle of the phalanx to be removed. The incision is made parallel with the extensor tendon, which is pushed to one side as soon as it has been exposed. The extensor tendon is raised, the lateral ligaments are severed, the ends of the bones are elevated, and as much bone as necessary removed with the bone forceps.

In **excising the last phalanx** the incision may be made along the palmar surface of the finger, or around the end of the finger. In the former case the soft parts are stripped from the sides of the bone, and in the latter from the dorsal and palmar aspects. The bone is then grasped with the bone forceps and twisted

Development of the Bones of the Upper Extremity.—The time of union of the various centers of ossification in the bones of the body plays an important part in the diagnosis and treatment of the various fractures which occur. This is especially so when the fracture is located near one of the epiphyseal ends of the bone.

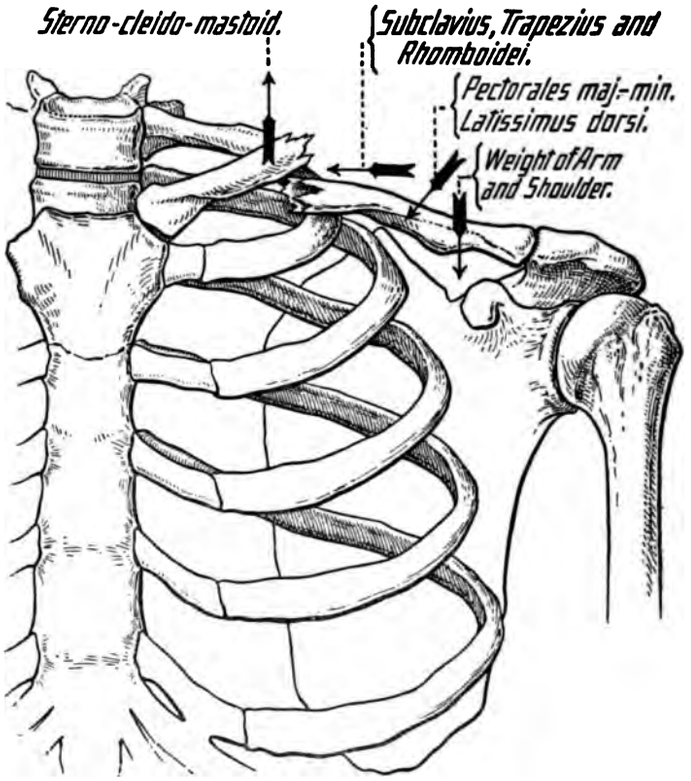
The **clavicle** has two centers of ossification—one for the shaft, and one for the sternal end. Ossification in the shaft begins about the sixth week of fetal life. The clavicle is the first bone in the body to show signs of ossification. About the nineteenth year an epiphysis appears at the sternal end, and subsequently unites with the remainder of the bone.

The **scapula** has seven centers of ossification—one for the body, two for the coracoid process, two for the acromion, one for the posterior border, and one for the inferior angle. At birth the body of the scapula is the only part which is ossified. The center for the middle of the coracoid process appears in the first year. The other centers appear in the fifteenth or sixteenth year, when the coracoid process joins the body of the bone. These epiphyses join and unite with the body of the bone between the twenty-second and twenty-fifth years.

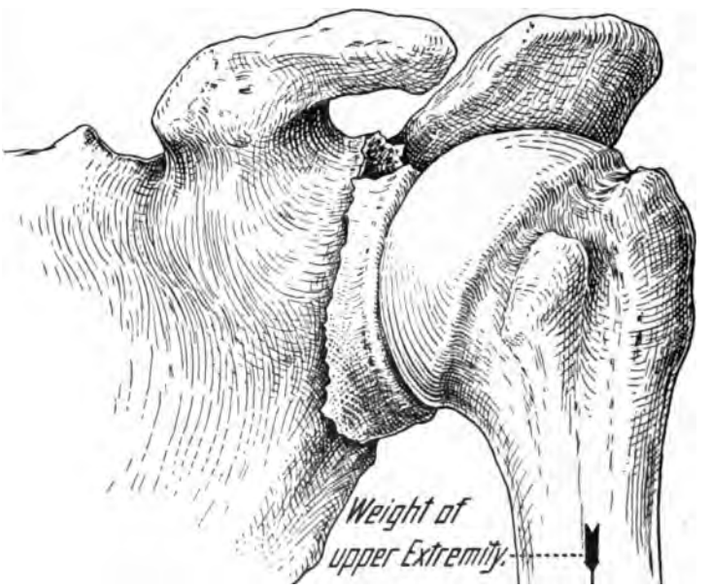
An **ununited epiphysis** of the acromion may be mistaken for an ununited fracture. The former condition is recognized by the presence of an ununited epiphysis upon the uninjured side also, whereas ununited fracture of the acromion is almost invariably unilateral.

The **humerus** has seven centers of ossification—one for the shaft, one for the head, one for the greater tuberosity, one for the capitellum, one for the internal condyle, one for the trochlea, and one for the external condyle, and, generally, one for the lesser tuberosity. These centers appear at different periods, and unite, as a rule, in the reverse order of their appearance. About the fifth year the centers for the head and tuberosities coalesce; the union of this epiphysis to the shaft does not take place, however, until about the twentieth year. The centers for the external condyle, capitellum, and trochlea coalesce and unite with the shaft

:placement in Fracture of the middle of the Clavicle.



Fracture of Anatomical Neck of Scapula.



The **ulna** has three centers—one for the shaft and coronoid process, one for the olecranon, and one for the lower end. The lower end unites to the shaft about the eighteenth year, and the olecranon center, although it does not begin ossification before the eighth, unites to the shaft about the sixteenth year.

The **carpal bones** each have but a single center of ossification, and these appear after birth, at different periods.

The **metacarpal bones** have two centers—the metacarpal bones of the fingers have a center for the shaft and proximal end, and another for the distal end; the metacarpal bone of the thumb has a center for the shaft and distal end, and another for the proximal end. These centers are united about the twentieth year.

Each **phalanx** has two centers—one for the shaft and distal end, the other for the proximal end. They unite about the twentieth year.

FRACTURES.

The treatment of fractures aims: (1) To return the parts to their normal relations; (2) to continuously keep the fragments and their ends steady, this requiring a splint, or other stiff dressing, which extends throughout the length of the fragments and beyond joints moved by muscles attached to the fragments; (3) to retain the function of joints or tendons in close proximity by passive movement practised as soon as union is sufficiently firm.

Fracture of the clavicle is very frequent because it holds an exposed position and is the only bony connection between the upper extremity and the trunk. As about one-half of these fractures occur in children under five years of age, green-stick fracture of this bone is common. In this form of fracture there may be little displacement, and the true condition may not be detected until callus forms and a swelling is produced. If a child has fallen and cries constantly, the clavicle should be carefully examined.

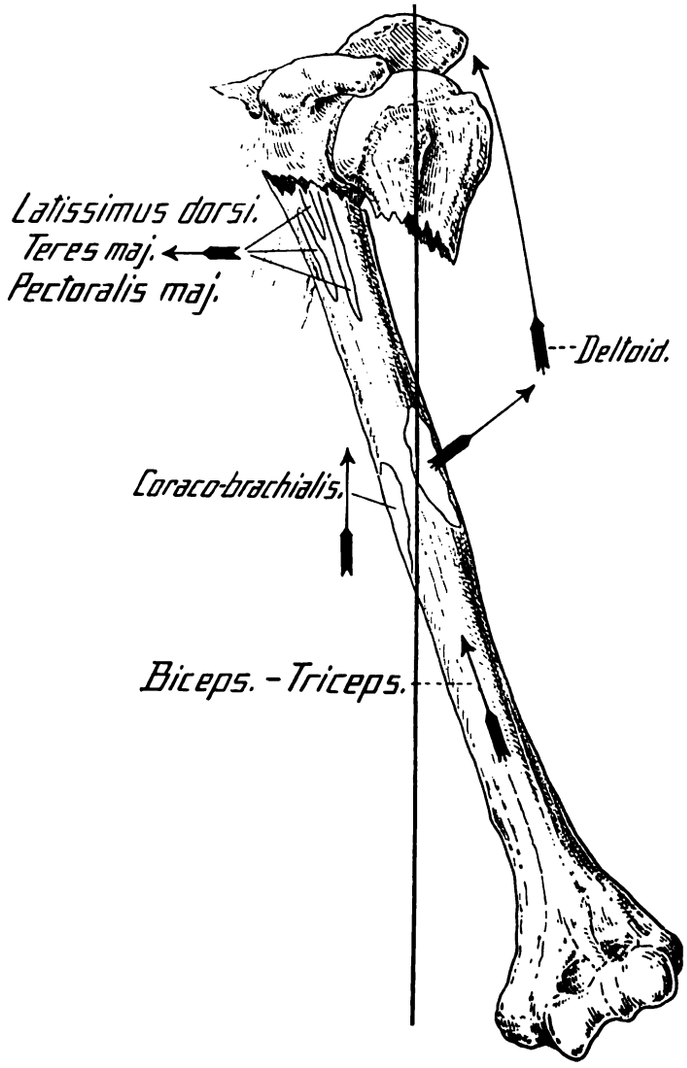
In comminuted fracture of the clavicle there is danger that the subclavian vein, subclavian artery, or brachial plexus may be injured. These structures are protected by the intervening subclavius muscle and prevertebral fascia, and therefore this complication is rare. If the vein or the artery be torn, the blood gravitates to the axilla through its apex, and the resulting condition is a traumatic

Fractures of the clavicle generally occur near the outer end of the middle third. The reasons for the greater frequency of fractures in this position are that the bone at this situation is smaller and consequently weaker, and begins to bend forward and derives less support from the muscles and ligaments. The deformity in fracture of the middle third of the clavicle is displacement of the inner fragment upward, and of the outer fragment downward and inward. The inner fragment is drawn upward by the sterno-cleido-mastoid. The outer fragment is drawn downward by the weight of the arm and shoulder; downward and inward by the pectoralis major, the pectoralis minor, and the latissimus dorsi; inward by the subclavius, trapezius, and rhomboidei muscles.

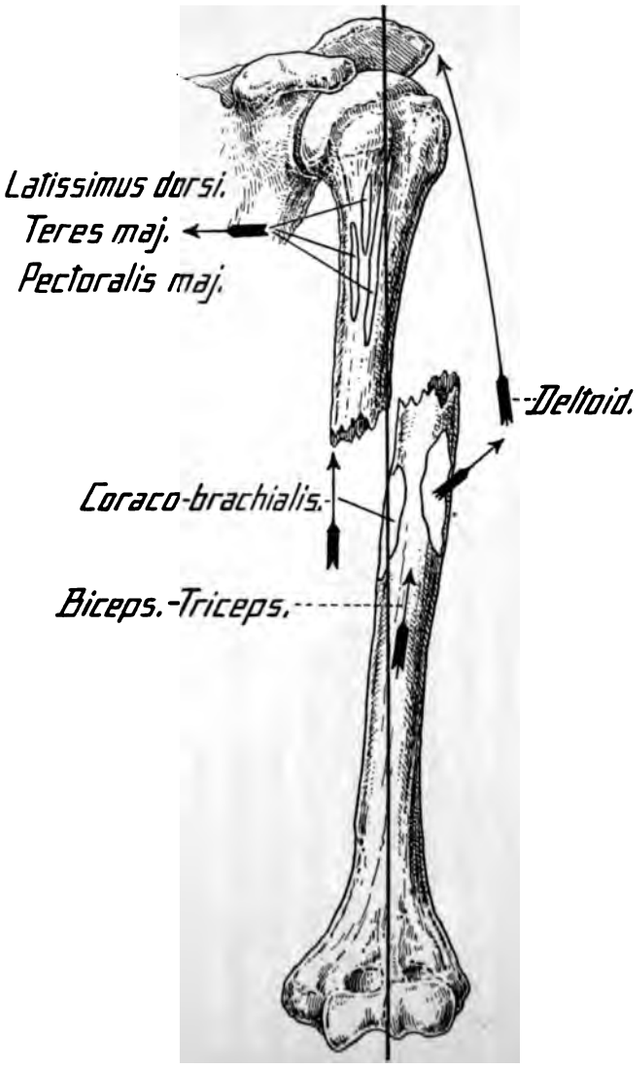
In displacement of the inner fragment upward the action of the sterno-cleido-mastoid is antagonized by the rhomboid ligament, the clavicular portion of the pectoralis major, and the inner fibers of the subclavius muscle.

The clavicular fibers of the trapezius antagonize the downward displacement of the outer fragment, and the serratus magnus its inward displacement.

Fractures of the scapula are uncommon, only one per cent. of all fractures occurring in this bone. This is due to the free mobility of the bone and to its protection by overlying muscles. Fractures may involve any portion of the bone. They are usually produced by direct violence, but may be caused by muscular action or by indirect violence, as a fall upon the arm. Fractures of the *body* of the scapula not involving the spine of the bone are detected with difficulty, because of the thickness of the overlying muscles; whereas those of the spine and acromion are readily detected because of their superficial position. Fracture of the *anatomic neck* of the scapula, which is external to the coracoid process, is so rare that but one case has been recorded. This condition simulates subglenoid dislocation, in that the arm is lengthened as the arm and glenoid cavity drop downward. It is readily differentiated from subglenoid dislocation by raising the arm, when crepitus may perhaps be elicited. As soon as support of the arm is withdrawn, the arm again lengthens. In fracture of the anatomic neck of the scapula, injury of or pressure upon the axillary vessels and brachial plexus is almost certain to occur. In fracture of the *surgical neck* of the scapula the glenoid cavity and arm are prevented from dropping downward by the attachment of the coracoid process to the clavicle by the coraco-acromial ligament, unless the latter is torn. Fractures



FRACTURE THROUGH SURGICAL NECK.



FRACTURE ABOVE INSERTION OF DELTOID M.

They may occur through any of the various divisions of the bone, as the anatomic neck, the tuberosities, the surgical neck, the middle third of the shaft, the external or internal condyle, the shaft immediately above the condyles and between the condyles. Separation of the epiphysis may occur at either extremity of the bone.

In fracture of the *anatomic neck* there is often little, if any, deformity and displacement, owing to the fact that the break is largely within the capsule of the joint. As such fractures are usually due to indirect violence, the head of the bone may be forced into the cancellous tissue of the lower fragment and an impacted fracture result.

In fracture through the *greater tuberosity* the antero-posterior diameter of the shoulder-joint is increased, and a sulcus exists between the front of the joint and the fragment. The rotundity of the shoulder is altered but not lost. The fragment is drawn upward and backward by the action of the supra-spinatus, infra-spinatus, and teres minor muscles, which are inserted into the greater tuberosity.

In fracture of the *surgical neck* the line of the break is below the tuberosities, and above the insertion of the teres major and latissimus dorsi. The upper fragment is rotated outward and slightly abducted by the action of the muscles attached to the greater tuberosity. The lower fragment is drawn upward toward the axilla by the biceps, triceps, coraco-brachialis, and deltoid; and inward by the pectoralis major, teres major, and latissimus dorsi muscles. Marked displacement of the lower fragment is prevented by the long head of the biceps in front and the long head of the triceps behind.

In persons under twenty years of age *epiphyseal fracture* is more likely to occur than fracture of the surgical neck of the humerus, and as the length of the bone is chiefly derived through growth of this upper epiphyseal cartilage, considerable shortening is likely to result.

In fractures of the *shaft* of the humerus the displacement will depend upon the location of the fracture. If it be above the insertion of the deltoid and below the insertion of the pectoralis major, the upper fragment will be drawn inward by this latter muscle as well as by the teres major and latissimus dorsi. The lower fragment will be drawn directly upward and external to the upper fragment by the action of the deltoid, and, indirectly, by the biceps and triceps and the coraco-brachialis muscles. If the fracture be immediately below the insertion of the

When the lower part of the shaft of the humerus is broken, there is but little displacement, because of the broad attachment of the brachialis anticus in front and the counterbalancing influence of the triceps behind.

In *supra-condyloid* fracture the displacement is similar to that of a backward dislocation of both bones of the forearm. The upper fragment overrides the lower, and the latter is displaced backward by the action of the brachialis anticus and biceps, and upward by the biceps and the triceps. The brachialis anticus and biceps, by flexing the elbow-joint, tilt the lower fragment backward.

Fractures of the *condyles* are not very frequent. They may or may not be associated with an intercondyloid fracture. The main deformity is a widening of the elbow-joint, with downward displacement of the condyle.

In *intercondyloid* fracture the deformity is widening of the joint and inward displacement of the olecranon.

After fracture of the condyles there is not infrequently seen an inward deflection of the bones of the forearm at the elbow. In the normal condition, with the forearm extended and supinated, the radius and ulna form an obtuse angle with the humerus, so that when the arm lies at the side of the body, the hand projects away from the median line of the body. By an upward displacement of the inner condyle, or a downward of the outer, this angle may be lost, and the so-called "gun-stock deformity," described by Allis, is then produced.

In fractures of the upper end of the humerus—*i. e.*, of the surgical or anatomic neck—the circumflex nerve may be injured, in fracture of the shaft the musculo-spiral nerve, and in fracture of the internal condyle the ulnar nerve. When the symptoms of nerve injury appear shortly after or at the time of the occurrence of the fracture, they are caused by laceration or pressure by a fragment; but if they develop late, they are the result of pressure by callus. The character of the symptoms presented depends upon the amount of pressure exerted. Moderate pressure irritates the nerve, and causes tingling and pain in the area of distribution of its sensory branches, and spasm of the muscles supplied by its motor

LATE LXXI.

Flex. carpi rad.
Flex. longus pollicis.
Supinator longus.
Ex. carpi rad. longior.
" " brevior.
Extensors of thumb.
Pronator quadratus.
Deltoid.

brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, supinator brevis, extensor ossis metacarpi pollicis, extensor longus pollicis, extensor brevis pollicis, and extensor indicis. Paralysis of the triceps is unlikely because of the high origin of the branches to that muscle. The condition which results from paralysis of the musculo-spiral nerve is known as "wrist-drop." The hand is pronated and the wrist and fingers flexed. Loss of opposition from the extensors, which steady the fingers during flexion, causes loss of power in grasping objects.

When the ulnar nerve is affected, there is pain or anesthesia in the ulnar side of the forearm and hand, in the little finger and ulnar half of the ring finger, and there is spasm or paralysis of the flexor carpi ulnaris, ulnar side of the flexor profundus digitorum, the palmaris brevis, short muscles of the little finger, two ulnar lumbricales, interossei, adductor pollicis, and inner head of the flexor brevis pollicis. Paralysis of the interossei unbalances the state of equilibrium existing between the flexors and extensors, and as a result the first phalanges are extended and the distal phalanges partially flexed. This produces a "*clawed hand*," or "*main en griffe*." Power of flexion of the little and ring fingers is lost, and power of movement of the thumb is much diminished.

Fracture of the radius.—The radius usually sustains fracture about the lower one-third, where it occurs much more frequently than in the middle or upper one-third.

In fracture of the *head* or *neck* of the radius the lower fragment is carried upward and forward by the biceps, which is inserted into the tuberosity. Many surgeons and anatomists claim that it is impossible to have a fracture of the neck of the radius, unless it be complicated by some other fracture or a dislocation. The author has proved by X-ray photography and subsequent operation that simple fracture of the neck of the radius does occur.

Fracture of the radius may occur between the insertion of the biceps and that of the pronator radii teres, although such a fracture is very rare. The upper fragment would be strongly supinated by the action of the biceps and the supinator brevis, and the lower would be pronated and approximated toward the ulna by the pronator radii teres and the pronator quadratus. As the two strong supinators,

known as the "silver-fork deformity." The displacement of the fragments is partly due to the extensors of the wrist and fingers. The hand is carried to the radial side by the supinator longus, the extensores carpi radialis longior and brevior, and the extensors of the thumb, they being rendered tense by the displacement of the lower fragment.

The ulna may be fractured at any point. As a rule, fracture of the ulna is caused by direct violence, and for this reason there is no uniform displacement of the fragments, as this must vary with the angle of impact at which the breaking force operates. If there be any usual direction for displacement of the fragments, it is probable that the lower fragment would be drawn toward the radius by the action of the pronator quadratus. The upper fragment can only be displaced to any extent backward or forward, because of its connection with the humerus at the elbow-joint.

Fracture of the *coronoid process* is exceedingly rare. If it should occur, the process will probably be drawn upward by the brachialis anticus, which is attached to its base. As the coronoid process forms the anterior wall of the greater sigmoid cavity of the ulna, this fracture is usually associated with a backward dislocation of either this bone alone or of both the radius and ulna.

In fracture of the *olecranon process* the displacement of the upper fragment is always upward, and is determined by the action of the triceps. The extent of the displacement depends upon the degree of the breaking force and upon the extent of the rupture of the ligaments which surround the elbow-joint. If the forearm be markedly flexed at the time the fracture occurs, it is probable that the ulna will be dislocated forward by the action of the biceps and the brachialis

The displacement in **fractures of the phalanges** is never very great. When present it is usually transverse and due to the direction of the breaking force. If the line of fracture be oblique, there may be some overlapping.

AMPUTATIONS.

In amputations the following considerations should be borne in mind: (1) Save the patient's life. (2) Obtain a useful stump. (3) Secure a sufficient and healthy cutaneous covering for the end of the stump, with little redundant muscular tissue therein. All tendons are cut even with the end of the bone or bones and not drawn out, as it is desirable that they adhere to the cicatricial tissue and add to the mobility of the stump. Large nerves should be gently drawn out and severed on a level with the end of the bone, so that they will retract within their sheaths and the bulbs, or false neuromata, which form upon their cut ends will not be included in the cicatrix and cause a painful stump. (4) The flaps should usually be made by dissection, and be of sufficient length to avoid the formation of a conic stump and allow free mobility of the stump. (5) The resulting scar should not be in the middle of the end of the stump, because pressure upon the scar causes pain, and usefulness of the member will be thereby lessened. In the thigh and leg it should be situated posteriorly; this result is secured by making a long anterior and a short posterior flap. In this location the greater contraction of the muscles divided upon the dorsal aspect tends to retract the scar still further posteriorly. At the wrist or ankle or in the foot a palmar or plantar flap is desirable, as it is best adapted for bearing pressure. (6) It is well to save as much of the limb as can be retained with safety and future utility, as the danger of the operation increases with the length of the limb removed. (7) A deformed and ugly living appendage is likely to be of greater utility than the best artificial one. After the operation is completed, the

Of the various methods of amputation which have been adopted, only those which have proven most satisfactory to the author will be described.

The methods of amputation adopted by the author include the following: The circular, the modified circular, the flap, Teale's, Spence's, Lister's, and the oval.

The method adapted to any operation depends upon the position, conformation, and anatomy of the part to be amputated and upon the condition of the tissues in that locality. No one method is expedient in all locations; for while in one place the circular method gives good results, better results are obtained in other situations by one of the flap methods.

The circular method.—In the original circular method the bone and all other tissues were divided at the same level. At present in this method three incisions are made. The first incision divides skin and superficial fascia and separates the superficial from the deep fasciæ; in this manner a cuff of skin and superficial fascia equal in length to one-half of the diameter of the limb is dissected up and everted and rolled up as high as possible. The second incision divides the deep fascia and underlying tissues at the level of the attachment of the cuff of skin and superficial fascia; and the third divides the bone as high as possible while the soft tissues are retracted. The resulting wound is in the form of a pit with the sawed end of bone at the bottom; in this way the danger of a resulting conic stump is eliminated. The advantages of the circular method are that in a fleshy limb it avoids a redundance of useless muscular tissue in the stump. All the vessels are divided transversely, contract and retract well, while unnecessary hemorrhage is avoided. The surface of the wound is smaller than in other methods; for this reason union occurs more promptly and the resulting cicatrix is smaller. The disadvantages are that the cicatrix extends across the middle of the end of the stump and is adherent to the bone. This is likely to cause a tender stump, and in the lower extremity will be a great disadvantage, as the patient can not bear any weight upon the stump. As the corners of the stump wound are always puckered, the edges of skin do not lie in apposition and union does not, therefore,

level. This method differs from the circular method only in having two small flaps of skin and superficial fascia and a short sleeve of skin and superficial fascia instead of a long sleeve of skin and superficial fascia to cover the stump. The circular method is well adapted to amputations of the arm, where the part does not taper from above downward. Where the part tapers, as in a muscular forearm or calf of the leg, the modified circular is best. Both the circular and modified circular methods are well adapted to amputation of the arm and forearm where a scar across the middle of the end of the stump is not of serious disadvantage. These two methods give the longest possible stump.

The flap method.—The flaps are made by cutting from without inward (dissection), or from within outward (transfixion). The flap furthest from the main vessel is usually made first. The advantages of this method are the following: It is more easily and readily performed than the circular method; it gives a thicker cushion for the stump, as the muscular tissue of the flaps disappears while some fibrous tissue of the muscles remains. The disadvantages are the following: Many of the blood-vessels of the part are divided obliquely and do not contract and retract well, and in ligaturing them it is necessary to exercise more care in order that the vessels may be tied entirely above where they have been severed; on account of the irregular contraction of the various muscles divided, the stump may be irregular; the surface of the wound is larger than in the circular method, and very thick muscular flaps are in themselves a disadvantage. The transfixion method of making flaps is more rapid than the method by dissection, but the skin is divided in an uneven line and the flaps are likely to be too thick.

The first objection can be avoided by dividing the skin and superficial fascia by dissection and then dividing the muscles, deep fascia, vessels, and nerves by transfixion.

The dissection method of making flaps requires more time, but the skin is

The advantages of this method are the following: The bone is well covered, the wound is in a position to allow free drainage, the cicatrix is not upon the end of the stump and hence is not likely to cause pain from pressure produced by an artificial limb. The chief disadvantages are as follows: The great length of one of the flaps necessitates a very high amputation; the operation requires much time, as the flaps must be accurately outlined; the doubling of the long flap by pressure upon the vessels may impair its nutrition; in malignant disease recurrence often takes place in one of the flaps on account of its length, which makes it more difficult to avoid including involved tissue; in injury of the soft parts an unnecessarily high amputation is required to secure good flaps; if the flaps fail to unite by first intention, the sagging of the long flap prolongs recovery by increasing the space to be filled by granulation tissue; the area of the wound is extensive, and too much bone is sacrificed.

In **Spence's method** a long anterior and a short posterior flap are made. The long flap is not so long, and the short flap is longer than in Teale's method, and the tissues are cut obliquely from without inward to the bone. The soft parts are retracted from the bone, which is sawed two inches above the bases of the flaps. This method is best adapted to the lower third of the thigh and to a very muscular limb. The advantages are: That the long flap is not doubled upon itself; that if union by first intention does not occur, there is not much tendency to separation of the flaps and the wound is more manageable; that a good covering is afforded for the stump, and that the cicatrix is not upon the center of the end of the stump.

In **Lister's method** a long anterior flap, equal in length to two-thirds of the diameter of the limb, and a short posterior flap, equal in length to one-half of that of the anterior flap, are made. The flaps are procured by dissection, and are chiefly composed of skin and superficial fascia—although some deep fascia and

The **oval method** is similar to the circular, except that it has a longitudinal incision at one side. When this cut is very long, the incision is said to be racket-shaped. This method is best adapted to amputation of the fingers and toes.

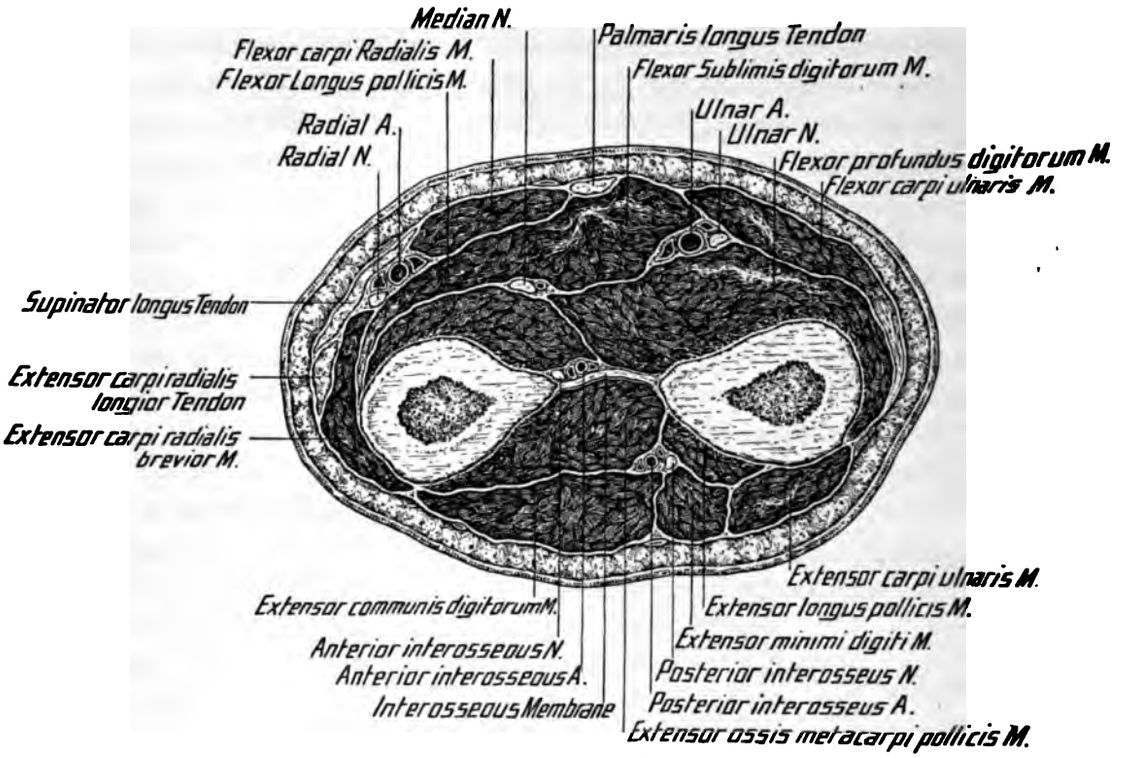
Amputation of the phalanges.—Phalanges are usually amputated because of injury, or the results of whitlow or felon. The base of the phalanx may not be affected by necrosis, as the periosteum is protected by the insertions of the flexor and extensor tendons. In removing a portion of the finger through the continuity of the phalanx, two oval flaps—one anterior and one posterior—are made. The palmar flap is the longer, in order to preserve as much as possible acute tactile sense for the end of the stump. The structures divided will depend upon the distance of the incision from the metacarpal bone and the finger amputated. In these amputations the skin and superficial fascia, with the collateral digital arteries, which receive blood from both the radial and ulnar arteries, will be divided. The nerves severed in the amputations are, in the case of the little finger, branches of the ulnar nerve; of the ring finger, branches of the ulnar, median, and radial nerves; of the middle and index fingers and thumb, branches of the median and radial nerves.

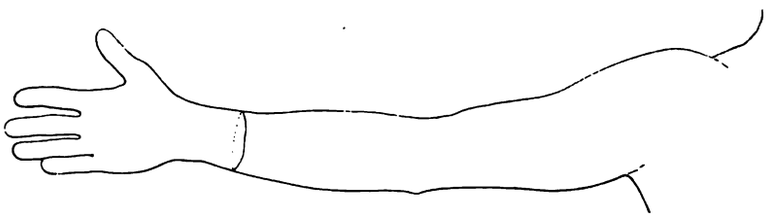
In amputation through the last phalanx no tendons will be divided. In amputations of the distal phalanges of the fingers, the tendons of the extensor communis digitorum and flexor profundus digitorum are divided. When amputating the second phalanx of the fingers, the tendons of the flexor sublimis and flexor profundus digitorum and extensor communis digitorum are severed. In amputations of the first phalanx of the thumb, the tendons of the extensor primi internodii pollicis, extensor secundi internodii pollicis, flexor longus pollicis, and of the short muscles of the thumb are divided. In amputating the second phalanx of the thumb, the tendons of the flexor longus pollicis and extensor secundi internodii pollicis are severed; in amputating the proximal phalanx

Disarticulation of the four metacarpal bones of the fingers.—In disarticulating these bones from the carpus by transfixion the point of the knife is inserted at the junction of the metacarpal bone of the little finger with the carpus, pushed through the soft parts of the palm of the hand close to the bones, and brought out in the fleshy tissue between the thumb and index finger. The knife is then carried downward and forward (away from the bones), cutting through the flexor brevis minimi digiti, opponens minimi digiti, abductor minimi digiti, adductor pollicis, palmaris brevis and lumbricales muscles, the tendons of the flexor sublimis digitorum and flexor profundus digitorum, the profunda branch of the ulnar artery and nerve, the deep palmar arch, the digital arteries and nerves, the deep and superficial palmar fasciæ, and the skin. The hand is then pronated, and a semicircular incision, with the convexity downward, carried across the dorsal surface joining the two ends of the palmar incision. The dorsal incision divides the skin and superficial fascia, some of the radicles of the radial, anterior and posterior ulnar veins, branches of the radial and ulnar nerves, the deep fascia, the tendons of the extensor carpi ulnaris, extensor minimi digiti, extensor communis digitorum, extensor indicis, the synovial sheaths of the tendons, the dorsal interosseous arteries, and the dorsalis indicis. These two flaps are then dissected upward until the articulation is reached. The metacarpal bones should be disarticulated, beginning on the palmar surface. The capsular, palmar, dorsal, and interosseous ligaments are severed and the hand removed. The sheaths of the flexor and extensor tendons should be sutured, there being less liability of infection traveling along them than if they were allowed to remain open.

Amputation of the thumb at the carpo-metacarpal articulation.—In amputating the thumb at the carpo-metacarpal articulation the incision should be made along the junction of the dorsal and palmar integument and around the base of the proximal phalanx. The proximal extremity of the incision commences over

PLATE LXXII.


Median N.
Palmaris longus Tendon
Flexor carpi Radialis M.
Flexor Longus pollicis M.
Flexor Sublimis digitorum M.
Ulnar A.
Radial A.
Ulnar N.
Radial N.
Flexor profundus digitorum M.
Flexor carpi ulnaris M.
Supinator longus Tendon
Extensor carpi radialis longior Tendon
Extensor carpi radialis brevior M.
Extensor carpi ulnaris M.
Extensor communis digitorum M.
Extensor longus pollicis M.
Anterior interosseous N.
Extensor minimi digiti M.
Anterior interosseous A.
Posterior interosseus N.
Interosseous Membrane
Posterior interosseus A.
Extensor ossis metacarpi pollicis M.



usually performed after injuries, and not when the wrist or carpal joints are diseased, because then the inferior radio-ulnar joint is affected and these movements would necessarily be lost. This amputation is performed by making anterior and posterior semilunar flaps, with their convexity downward. The anterior incision extends from one styloid process to the other, and passes through the skin, superficial fascia with its small nerves, arteries, and veins, the deep fascia, and the following structures in the order named from the ulnar to the radial side: The tendon of the flexor carpi ulnaris, the ulnar nerve, ulnar artery and its venæ comites, the four tendons of the flexor sublimis digitorum, the four tendons of the flexor profundus digitorum, the palmaris longus, the median nerve and artery, the flexor longus pollicis, the tendon of the flexor carpi radialis, and the superficialis volæ artery.

The posterior incision divides the following structures: Skin, superficial fascia, branches of the radial and ulnar vessels and nerves, the radial, anterior, and posterior ulnar veins, the posterior carpal branch of the ulnar artery, the tendons of the extensor carpi ulnaris, extensor minimi digiti, extensor communis digitorum, extensor indicis, extensores carpi radialis brevior and longior, extensor secundi internodii pollicis, extensor primi internodii pollicis, extensor ossis metacarpi pollicis, the radial artery and its venæ comites, the anterior interosseous artery, the posterior interosseous artery and nerve, the anterior, posterior, external lateral, and internal lateral ligaments.

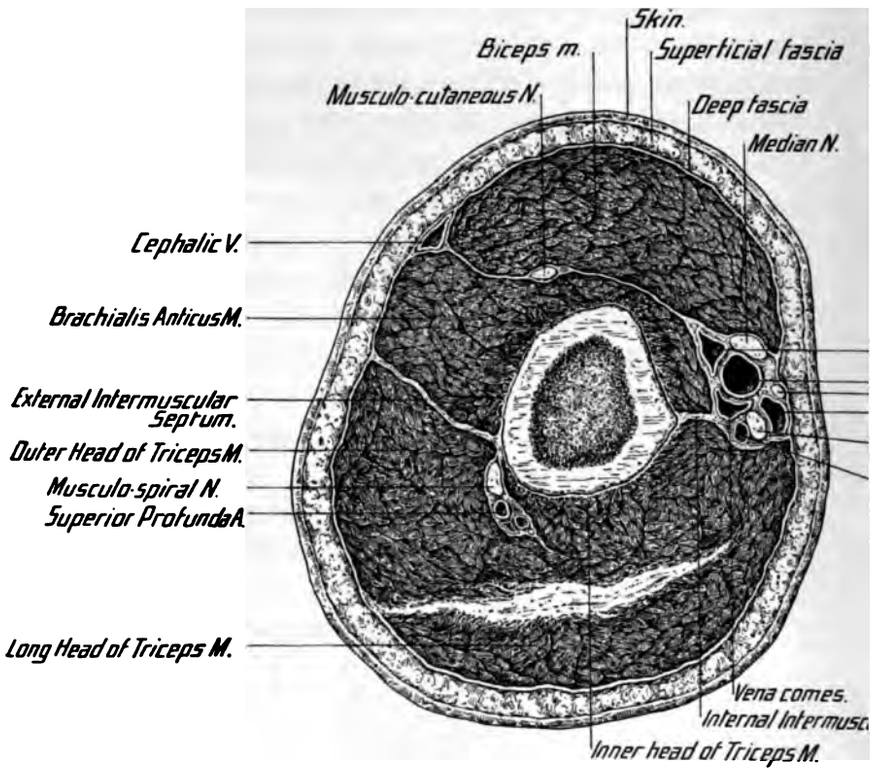
The principal arteries to be ligated are the radial and ulnar. The radial will be found on the radial side of the forearm, on the external lateral ligament of the wrist-joint just below the styloid process of the radius. The ulnar artery will be found on the anterior aspect of the forearm, just internal to the tendon of the flexor carpi ulnaris, and external to the tendons of the flexor sublimis digitorum.

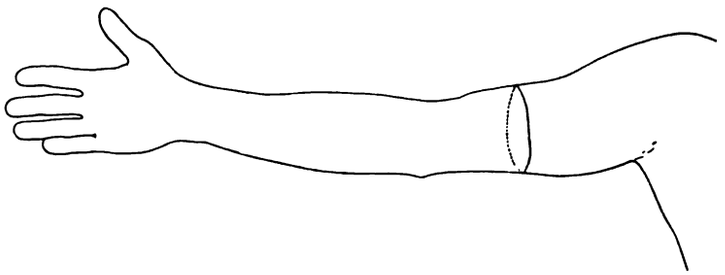
Amputation at the middle of the forearm.—This operation is generally performed by the antero-posterior flap method. The anterior incision is semilunar, with its convexity downward, passes from one border of the forearm to the other, and divides skin, superficial fascia, the radial, median, and anterior ulnar veins, the anterior branch of the musculo-cutaneous nerve, the anterior branch of the internal cutaneous nerve, cutaneous branches of the radial and ulnar arteries, the

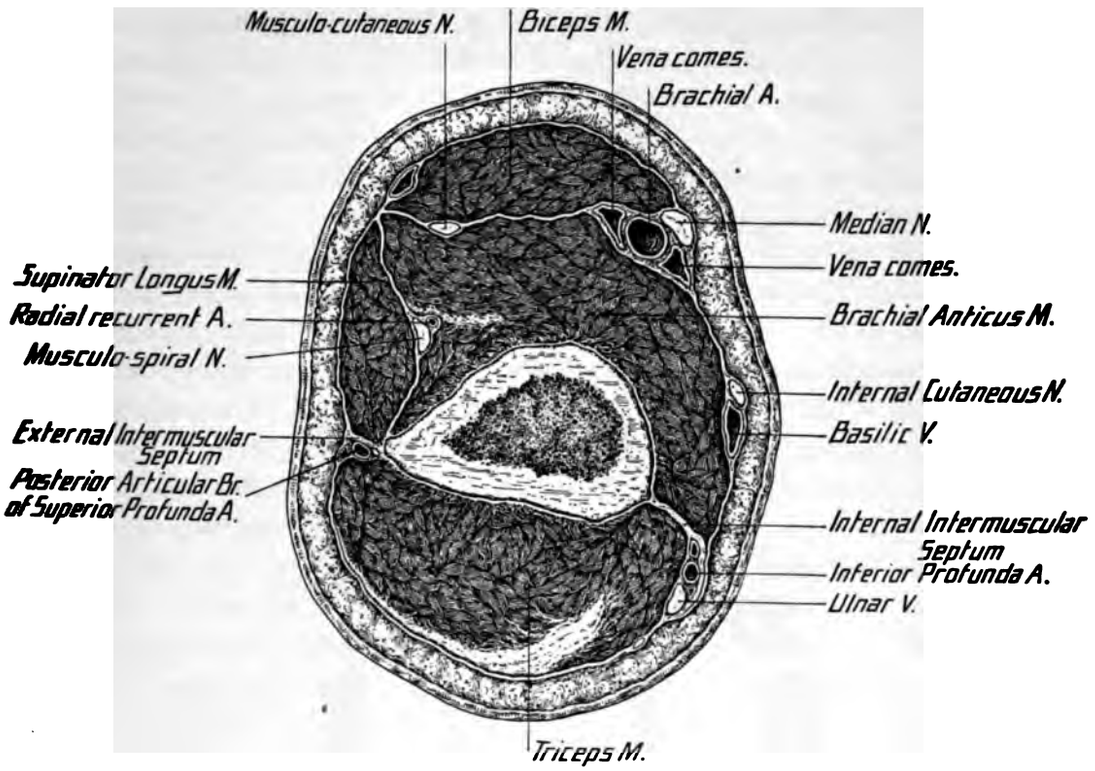
external cutaneous branch of the musculo-spiral nerve, the posterior branch of the musculo-cutaneous nerve, cutaneous branches of the radial and ulnar arteries, the deep fascia, the extensor carpi ulnaris, extensor minimi digiti, extensor communis digitorum, extensores carpi radialis longior and brevior, extensores primi and secundi internodii pollicis, extensor ossis metacarpi pollicis, and the posterior interosseous vessels and nerve. The interosseous membrane and the anterior interosseous vessels and nerve are divided. The bones should then be sawed, and the main vessels ligated. These will be the radial artery, which will be found between the pronator radii teres and supinator longus muscles; the ulnar artery, between the flexor carpi ulnaris, the flexores sublimis and profundus digitorum; the anterior interosseous artery, on the anterior surface of the interosseous membrane; and the posterior interosseous artery, between the superficial and deep extensors.

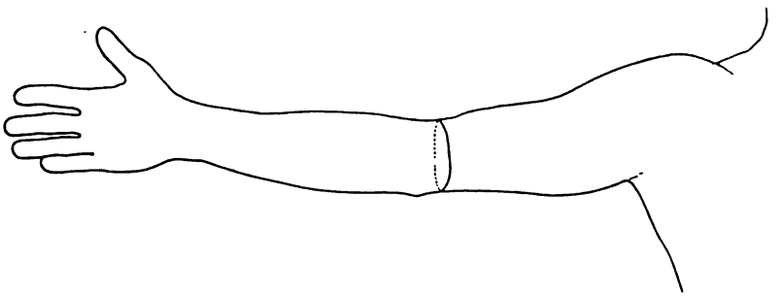
Amputation at the elbow-joint.—The most satisfactory method for performing this operation is by transfixion. The knife should be introduced about three-quarters of an inch below the internal condyle of the humerus, with the forearm supinated and slightly flexed. The object in flexing the forearm is to relax the anterior ligament so that it can be transfixed when the knife passes over the joint. The point of the knife should emerge from the radial side of the forearm the same distance below the external condyle. The knife should then be carried down the forearm for about four inches and brought abruptly to the surface. The structures severed will be the anterior ligament of the joint, the brachialis anticus, the supinator brevis, the posterior interosseous nerve, the tendon of the biceps, the extensor carpi radialis longior, the supinator longus, the flexor profundus digitorum, flexor longus pollicis, the common interosseous or anterior and posterior interosseous vessels, the anterior interosseous nerve, the

PLATE LXXIII.






Musculo-cutaneous N.
Biceps M.
Vena comes.
Brachial A.
Median N.
Vena comes.
Brachial Anticus M.
Internal Cutaneous N.
Basilic V.
Internal Intermuscular Septum
Inferior Profunda A.
Ulnar V.
Supinator Longus M.
Radial recurrent A.
Musculo-spiral N.
External Intermuscular Septum
Posterior Articular Br. of Superior Profunda A.
Triceps M.



of the posterior ligament. Next saw through the base of the olecranon, and remove the forearm by cutting the supinator brevis, interosseous recurrent artery, anconeus, extensor carpi radialis brevior, extensor communis digitorum, extensor carpi ulnaris, flexor carpi ulnaris, and deep fascia.

The principal vessels to be ligated are the radial, ulnar, common interosseous or anterior and posterior interosseous, posterior ulnar recurrent, and the interosseous recurrent artery. The radial artery will be found on the radial side of the flap, just beneath the ulnar margin of the supinator longus muscle. The ulnar artery will be found between the flexor sublimis digitorum and the flexor carpi ulnaris. The common interosseous or anterior and posterior interosseous arteries will be severed near their origin.

Amputation through the middle of the arm.—The circular or the antero-posterior flap method may be used in this amputation. In either the following structures will be severed on the front and inner side of the arm : Skin, superficial fascia, intercosto-humeral nerve, the internal cutaneous and external cutaneous branches of the musculo-spiral nerve, a cutaneous branch of the circumflex nerve, the lesser internal cutaneous nerve (nerve of Wrisberg), internal cutaneous nerve, branches of the superior and inferior profunda arteries, the cephalic vein, the deep fascia, the biceps and brachialis anticus muscles, the musculo-cutaneous nerve, the median nerve, the brachial artery and its venæ comites, the basilic vein, and the ulnar nerve; on the posterior aspect of the arm, the triceps muscle, the musculo-spiral nerve, the superior profunda artery,—the musculo-spiral nerve and the superior profunda artery will be seen immediately behind the bone, in close relation to that structure, and the brachial artery beneath the inner border of the biceps muscle.

Amputation at the shoulder-joint.—This amputation is performed for injury, tumors,—malignant or benign,—and disease of the joint. But one of the numerous methods of amputation at the shoulder-joint is described below, because practically the same structures are divided in all methods. The most important requisite is the surgeon's knowledge of the anatomy of the parts rather than of the different operations. The author prefers Spence's operation,—a modification of the oval method. It is especially adapted to those cases of injury where there has been much comminution of the humerus. The posterior circumflex artery is not severed, the head of the bone can be disarticulated very readily, and the resulting stump is generally full and round. The incision extends from a point just

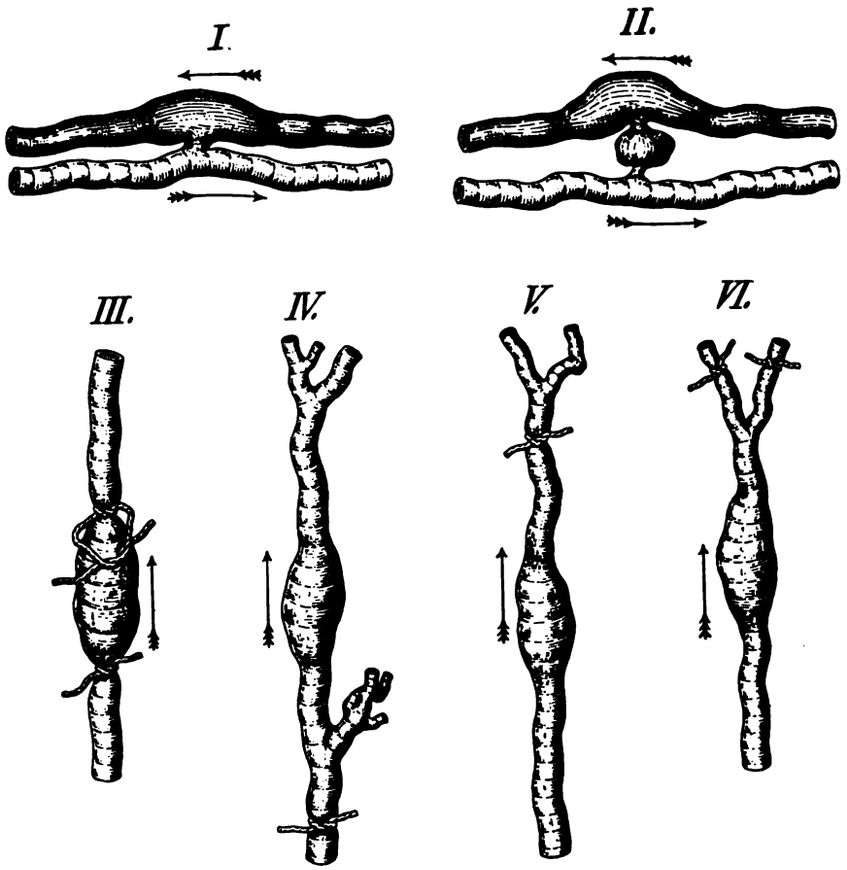
deep fascia, the cephalic vein, the humeral branch of the acromio-thoracic artery, the deltoid, the pectoralis major, and the anterior circumflex vessels. The incision is then carried backward, in a gentle curve, to the posterior border of the axilla. The skin and superficial fascia, with twigs of the posterior circumflex artery and circumflex nerve, the cephalic vein, the deep fascia, and the deltoid muscle will be severed.

The posterior flap can now be readily stripped from the bone and joint. The flap will carry with it the terminal part of the circumflex nerve and posterior circumflex vessels which enter its deep surface. The muscles attached to the greater tuberosity are then to be severed. They are the supra-spinatus, infra-spinatus, and teres minor. The subscapularis is next detached from the lesser tuberosity, the long head of the biceps divided, and the joint opened by dividing the capsular ligament. The arm is carried well inward, thus causing the head of the humerus to pass from the glenoid cavity. Before proceeding further a slight dissection of the axilla may be made to expose the axillary vessels, when they may be ligated before the remaining soft parts are severed; or the knife may be carried downward close to the bone on its internal aspect, the insertion of the teres major and latissimus dorsi muscles severed, and the anterior flap made by cutting from within outward. Care must be taken to have an assistant follow the knife downward with his fingers in contact with the vessels, and the outward cut should not be made until the surgeon is sure that the vessels are controlled by the assistant. The last incision severs the triceps muscle; the brachial vessels; basilic vein; the anterior circumflex artery; the ulnar, median, musculo-spiral, internal cutaneous, lesser internal cutaneous, internal cutaneous branch of the musculo-spiral, and the intercosto-humeral nerve; the deep fascia; superficial fascia, and skin.

LIGATIONS OF THE ARTERIES.

Arteries are ligatured in the treatment of aneurysms; to arrest hemorrhage; check malignant growths; and previous to some operations, as amputation at the shoulder and removal of the tongue.

Aneurysms are treated by medical and surgical means. The medical treatment consists of rest in bed in the recumbent position. Whenever possible, the part affected should be placed in such a position as to impede the flow of the blood current through the aneurysm, but not interfere with the return circulation. The


I.
II.
III.
IV.
V.
VI.

lower vascular pressure and allow the blood to begin to clot in the aneurysm. Drugs which lower vascular tension, such as veratrum viride and aconite, should be given; and iodid of potassium administered to break up the white corpuscles and liberate the fibrin ferment.

Various other methods of treating aneurysms have been practised. Among these are pressure, ligature, manipulation of the aneurysm, injection of coagulating materials, introduction of foreign bodies, and galvano-puncture.

Pressure applied to the artery to the proximal side of the sac has given good results, and acts by checking the passage of blood through the sac and allowing it to clot. Digital pressure may be applied by relays of trained assistants. Its feasibility, however, is limited to aneurysms of the arteries of the extremities, as the brachial, superficial femoral, and popliteal. The pressure may be applied more conveniently by means of tourniquets which do not interfere with the return circulation.

Ligatures have been used according to various methods. In the *method of Antyllus*, or the "old operation," the artery was tied on both sides of the aneurysmal sac. The sac was freely exposed, opened, the clot turned out, and the artery tied upon either side of the sac. This is not a good operation because there is copious bleeding, the artery is tied where its coats are diseased, and consecutive or secondary hemorrhage is likely to occur. This method is the one commonly practised in the treatment of traumatic false aneurysms. In these aneurysms there is not the same objection to tying the artery close to the aneurysm, since the walls of the vessel are not necessarily diseased at that point.

In the *method of Anel* the sac is exposed and the artery tied immediately above the sac. In this method, as in that of Antyllus, the artery is tied where its coats are diseased.

In *Brasdor's method* the main trunk of the artery is ligated some distance to the distal side of the aneurysmal sac. In *Wardrop's method* one or more of the main branches of the artery beyond the sac are tied. These two methods are applicable in aneurysms at the root of the neck, as of the innominate, common carotid, or subclavian.

In *Hunter's method* the artery is tied to the proximal side of the sac, and where the coats of the artery are sound, as in Brasdor's and Wardrop's methods; the ligature greatly reduces the force of the blood current and allows the blood to form a laminated clot in the sac. Nature, then, has an opportunity to form a clot and connective tissue within the sac, and obliterate that portion of the artery. The circulation is reestablished by enlargement of the arteries which arise above the ligature and anastomose with those which arise below the aneurysm. This

of the sac is not feasible. Pressure upon the carotids would be very painful, and therefore Hunter's method is used in preference to pressure in treating aneurysm of the external or internal carotid or upper part of the common carotid.

Manipulation of the aneurysmal sac to loosen parts of the fibrinous clot from its wall so that they will occlude the artery to the distal side of the aneurysm is a dangerous procedure, because embolism or rupture of the sac may result. Embolism from manipulation of the carotids may cause hemiplegia.

The **injection of coagulating material,** such as neutral ferric chlorid or fibrin ferment, may be practised if the artery is compressed on both sides of the sac for an hour or more during the injection. There is much danger from embolism, inflammation, and abscess.

The **introduction of foreign bodies,** such as fine aseptic wire, favors the formation of a clot. This method has been used in aortic and subclavian aneurysms, as these are unfavorable cases for ligature or pressure.

Galvano-puncture is not a favorable method of treating aneurysms; the clot is soft and therefore uncertain, inflammation of the sac and its contents may follow, and the eschar at the point of introduction of the needle may be the site of secondary hemorrhage.

Anatomy of an Artery.—The wall of an artery is composed of three coats—an internal, a middle, and an external.

The internal coat, or tunica intima, is composed of a layer of flat endothelial cells which lines the vessel wall, and an elastic layer which is chiefly composed of yellow elastic fibers arranged in a mesh-work, the majority of the fibers of which are in a longitudinal direction. This layer is united to a layer of endothelial cells by delicate areolar tissue. When an artery is ligatured, the internal coat curls inward and retracts, thus partially occluding the lumen of the artery and giving support to the clot of blood which undergoes organization. When an artery is completely divided, this coat curls inward, retracts, and contracts in the same manner as when it is ruptured in ligature of a vessel.

The middle coat, tunica media, is composed chiefly of circular muscular and some elastic fibers. The muscular fibers predominate in the smaller vessels, and the elastic tissue in the larger vessels. When an artery is completely divided, it is chiefly through this coat that it contracts, while retraction is produced by both the internal and the middle coat.

The external coat, or tunica adventitia, is composed chiefly of white fibrous tissue, and some longitudinal elastic fibers; this is the only coat of an artery

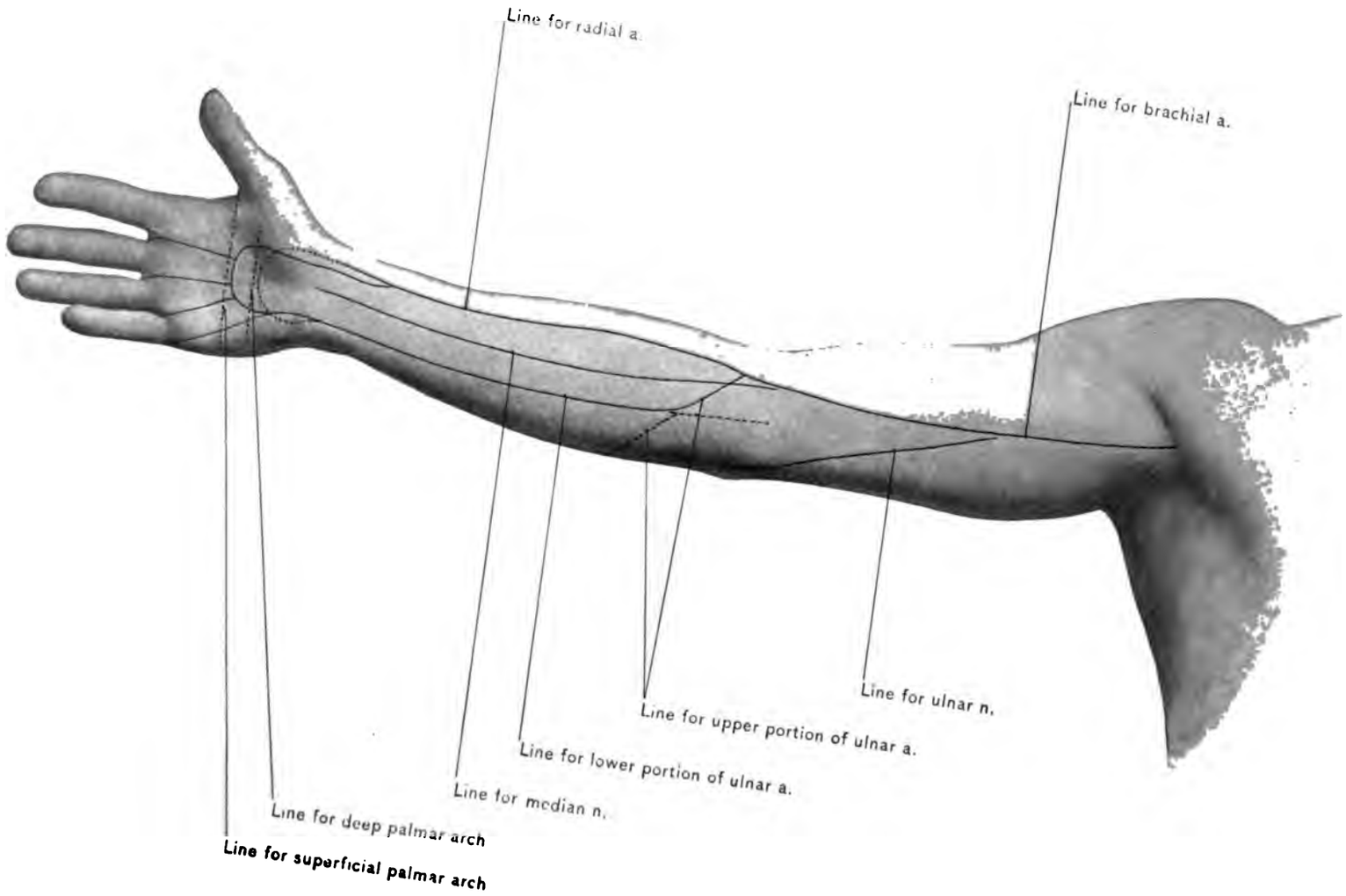
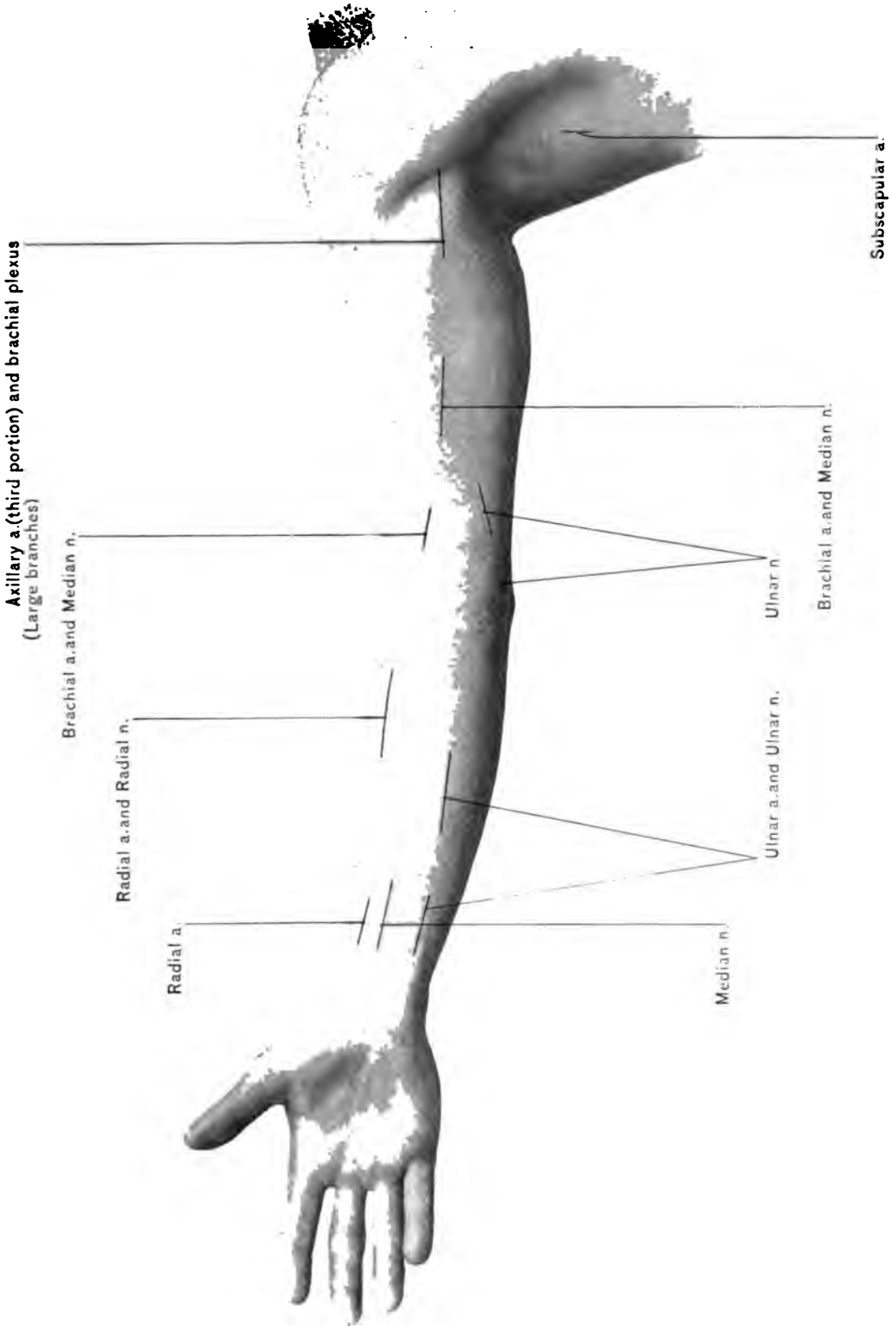

Line for radial a.
Line for brachial a.
Line for ulnar n.
Line for upper portion of ulnar a.
Line for lower portion of ulnar a.
Line for median n.
Line for deep palmar arch
Line for superficial palmar arch

PLATE LXX


Axillary a.(third portion) and brachial plexus
(Large branches)
Brachial a.and Median n.
Radial a.and Radial n.
Radial a.
Ulnar a.and Ulnar n.
Median n.
Ulnar n.
Brachial a.and Median n.
Subscapular a.

and some arteries, such as the common carotid and common femoral, have an additional sheath formed by the deep fascia. The sheath is loosely attached to the outer coat of the vessel and the surrounding structures, and gives support to the vessel wall.

When ligating an artery, it is customary to open the sheath and separate it from the vessel for a short distance before passing the aneurysm needle. By this procedure unnecessary pressure upon the vasa vasorum and increased risk of sloughing of the vessel are avoided. Where an artery has two sheaths, the internal as well as the external sheath must be opened.

In the **Ligation of Arteries** familiarity with the following rules is necessary: The ligature must not be placed too near the aneurysm because there the coats of the artery are diseased. If too great a distance intervene between the aneurysm and the point of ligation, the collateral circulation is too quickly established and blood passes through the sac, displaces the clot, and prevents organization. The ligature must not be too near a large branch, as the current of blood would then prevent clot formation and organization and increase the risk of secondary hemorrhage when the ligature is absorbed. The operator must be well acquainted with the course and anatomic relations of the vessel, with its anomalous forms and relations, and its superficial and deep landmarks. The incision through the skin and tissues over the sheath of the vessel should be sufficiently large to give ample room for the application of the ligature. As soon as the skin and fasciæ are divided, locate the anatomic guides to the artery and then search for the vessel, the pulsation of which will assist in finding it. All of the small superficial vessels and nerves are divided, while large ones are avoided and displaced. Each layer of tissue over the vessel is carefully divided so that the anatomic landmarks may not be lost. The cut edges of the different layers are separated, but separation of these layers is avoided as much as possible. After the sheath of the vessel is exposed it is carefully cleaned for a short distance and a small portion of it is pinched up and divided with the knife held flat and its cutting edge away from the vessel. The opening in the sheath should be very small. After the sheath is opened a small portion of it is suffi-

its position; for if the vasa vasorum be torn, the danger of secondary hemorrhage is increased by preventing nutrition.

The vasa vasorum should not be ruptured more than is necessary; this can be prevented if the operator will not unnecessarily separate the sheath from the artery, nor lift the vessel from its original position, nor depress the handle of the needle, thereby unnecessarily elevating the artery. The needle is always passed away from the structure which would be most endangered. If one vein accompanies the artery, the needle is passed away from the vein; if the artery has two venæ comites and one accompanying nerve, the needle is passed away from the nerve. The needle may be passed either armed or unarmed. Before the needle is withdrawn always compress the artery between the curve of the needle and the finger and notice if the pulsation in the artery or its branches beyond the site of the operation is checked, and if any other structures are included in the ligature. The ligature should always be tied at a right angle to the course of the artery; because if the ligature be placed obliquely, it is apt to become loose. The ligature is tied with a reef-knot, or a surgical knot, firmly enough to rupture the middle and internal coats of the artery.

The undesirable sequelæ of ligature of an artery are consecutive hemorrhage from loosening of the ligature or diseased coats of the vessel, secondary hemorrhage from the breaking down of these diseased coats, sloughing around the ligature or imperfect organization of the clot, and rupture of the vessel. Gangrene of the limb upon the distal side of the ligature may occur because of the slow and insufficient establishment of the collateral circulation. Sloughing of the sac may result. The pulsation in the sac may continue or return after having been absent: because the ligature was placed obliquely and became loosened, or was placed too far above the sac; the collateral circulation is too rapidly

and the accompanying vein is large, prominent, and closely connected with the costo-coracoid membrane. The third portion of the axillary artery is quite accessible, being covered for a short distance by the pectoralis major muscle, beyond which it lies just beneath the skin, superficial fascia and deep fascia when the arm is abducted. In front of the third portion of the artery, when the arm is abducted, are the pectoralis major muscle, axillary fascia, inner head of the median nerve, and the internal cutaneous nerve. Behind it are the musculo-spiral and circumflex nerves, the subscapularis muscle, and the tendons of the latissimus dorsi and teres major muscles. On the inner side are the ulnar nerve, the axillary vein, and the lesser internal cutaneous nerve (nerve of Wrisberg)—the latter being separated from the artery by the vein. On the outer side are the median and musculo-cutaneous (external cutaneous) nerves, the outer of the venæ comites of the brachial artery, and the coraco-brachialis muscle. The branches of this portion of the artery are the subscapular, anterior circumflex, and posterior circumflex. In ligating this portion of the axillary artery the arm should be carried outward to a right angle with the body. An incision is made in the line of the vessel, beginning at the middle of the floor of the axilla. It is then carried downward about three inches along the inner border of the coraco-brachialis muscle, which can be easily felt. The skin and superficial fascia, with small branches of the intercosto-humeral, internal cutaneous, and lesser internal cutaneous nerves, and branches of the long thoracic artery, are divided. The deep fascia is then incised, and the inner margin of the coraco-brachialis muscle exposed. The coraco-brachialis is drawn outward, and the position of the artery determined by its pulsation. The median nerve will then be exposed, and should be drawn outward, while the internal cutaneous nerve is drawn inward. The outer of the venæ comites of the brachial artery and the axillary vein being well exposed, the ligature can be passed around the artery from within outward.

The unusual forms and relations of the axillary artery are the following: The third portion of the artery may be covered by a muscular slip from the latissimus dorsi. In ten per cent. of cases there are two large arterial trunks instead of one; one of them may be a common trunk of origin for the long thoracic, subscapular, posterior circumflex, and superior profunda arteries, while the other is the continuation of the axillary, and continues to form the brachial; or

The *collateral circulation* after ligature of the third part of the axillary artery above the origin of the subscapular is established by the anastomosis of—

The suprascapular and acromio-thoracic arteries.	with	the anterior and posterior circumflex arteries.
The suprascapular, posterior scapular and long thoracic arteries	with	the dorsalis scapulæ and subscapular arteries.
The intercostal branches of the aorta and internal mammary artery	with	the subscapular artery.

When the artery is tied between the origin of the subscapular and circumflex arteries, the collateral circulation is established by the anastomosis of—

The suprascapular and acromio-thoracic arteries.	with	the anterior and posterior circumflex arteries,
	and	
The subscapular artery	with	the posterior circumflex artery.

The subscapular artery.—The arm is abducted to a right angle with the body, and the artery is exposed by an incision made through the floor of the axilla along the anterior border of the posterior fold of the axilla. The skin, superficial fascia, superficial vessels, posterior branches of the lateral cutaneous nerves, and the axillary fascia, are divided. The artery is found to the inner side of the anterior border of the latissimus dorsi, lying in the areolar tissue in front of the subscapularis muscle. The incision should avoid the axillary vessels which are upon the outer wall of the axilla. The long *subscapular nerve* lies to the inner side of the upper one-third of the artery and in intimate relation with the middle one-third. The *subscapular vein* lies in front of the artery at its origin, and holds a varying relation to the remainder of the artery. The *dorsalis scapulæ artery* arises from the subscapular artery about one inch from the origin of the latter. The lower *subscapular* nerve passes toward the teres major muscle just above or below the

space is bounded upon the outer side by the humerus, upon the inner side by the long head of the triceps, above by the teres minor, and below by the teres major. As the nerve passes through the space it supplies a branch to the teres minor, branches to the deltoid, and gives off cutaneous branches to the skin over the deltoid.

The **brachial artery** is the continuation of the axillary artery, and begins at the lower edge of the tendon of the teres major muscle. Its course is on the same line as the axillary artery—namely, from just to the inner side of the middle of the clavicle to the middle of the bend of the elbow, with the arm at a right angle to the body; or from the junction of the anterior one-third with the middle one-third of the outer part of the floor of the axilla to the middle of the bend of the elbow. The artery is practically subcutaneous throughout its entire extent; except in the middle of its course where the median nerve lies in front of it; and at its lower end where the bicipital fascia and median basilic vein are in front.

In front of the artery are the skin, superficial and deep fasciæ, inner border of the coraco-brachialis and biceps muscles, the median nerve at the middle of the arm, the median basilic vein, internal cutaneous nerve, and bicipital fascia at the bend of the elbow. Behind it, from above downward, are the long head of the triceps, the musculo-spiral nerve, the superior profunda artery, the inner head of the triceps, the insertion of the coraco-brachialis, and the brachialis anticus muscle. To its inner side are the ulnar nerve in the upper half of the arm, the internal cutaneous nerve and the basilic vein in the upper two-thirds of the arm, and the median nerve at the bend of the elbow. To its outer side are the coraco-brachialis and biceps muscles, as well as the median nerve in the upper part of the arm, and the tendon of the biceps at the elbow. Two veins accompany the artery, one lying on each side of it.

The artery may be ligated *at the bend of the elbow*, or at the middle of the arm. In ligating it at the bend of the elbow the arm should be slightly flexed in order to make prominent the tendon of the biceps. The median, median basilic, median cephalic, and deep median veins usually join on a level with the point where the tendon ceases to be felt distinctly. Having located these points, the forearm should be extended and the arm abducted and allowed to rest on the olecranon. An incision, about two inches long, is made along the inner edge of the tendon of the biceps; the upper end of the incision being about on a level with the tip of the internal condyle. The skin, superficial fascia, the anterior

exposed. The deep fascia and bicipital fascia are divided in the line of the original incision, and the artery with its venæ comites and the median nerve, which lies to its inner side, exposed. The veins should be separated from the artery, its sheath opened, and the ligature passed around the artery from within outward.

Ligature of the brachial artery or stretching of the median nerve at the bend of the elbow is not an advisable operation, because, if possible, scars should not be made at flexures of joints.

In ligating the brachial artery in *the middle of the arm* the incision should be made along the inner edge of the biceps muscle. The skin, superficial fascia, twigs of the internal cutaneous nerve, and small branches of the superior profunda and anterior circumflex arteries will be divided. The deep fascia is then incised and the inner edge of the biceps muscle clearly demonstrated. The muscle is displaced outward, and the position of the artery determined by its pulsations. The median nerve is then exposed, generally lying over the artery in this part of its course. It should be drawn inward and the sheath of the vessel opened. The venæ comites are then separated from the artery, and the ligature passed from within outward away from the basilic vein.

After ligature of the brachial artery above the origin of the superior profunda artery the *collateral circulation* is established by the anastomosis between the posterior circumflex and superior profunda arteries.

In ligating the brachial artery it is to be remembered that in about twenty per cent. of all cases there are two large arteries in the arm instead of one. This is due to the high origin of either the radial or ulnar artery, or to the presence of a vas aberrans. A third head of origin of the biceps sometimes crosses in front of the brachial artery near the middle of the arm. The median nerve is frequently under instead of over the middle portion of the artery. The brachial artery and the median nerve rarely pass toward the posterior surface of the internal condyle; they pass around the supra-condyloid process and then in front of the elbow. This artery is most readily compressed at the middle of the arm where it lies upon the coraco-brachialis muscle; it is usually ligated in this location.

The brachial artery is sometimes ligatured for an arterio-venous aneurysm. This is usually caused by a wound which involves both the artery and the adja-

its valves. There ensues distention and a varicose condition of the adjacent superficial and deep veins. These veins become elongated, tortuous, thickened, and may pulsate; but a characteristic aneurysm is not formed. In a *varicose aneurysm* the inflammatory exudate which binds together the wounds in the artery and vein has yielded and a sac is formed by distention of the channel which connects the two vessels. The blood passes from the artery through the connecting channel and its sac and into the vein. The most common cause of varicose aneurysm in connection with the brachial artery is venesection practised upon the median basilic vein, which crosses the brachial artery. As the vein is now opened with a bistoury, aneurysmal varix as the result of venesection is rare.

Punctured or gunshot wounds, however, may cause a varicose aneurysm. In both varieties of arterio-venous aneurysm there is pulsatile dilatation of the veins, a thrill, and a continuous murmur. The murmur is heard along the course of the veins toward the heart. In the varicose form a murmur may be detected at the position of the sac, and there is always a thrill synchronous with the beat of the heart.

These aneurysms are treated by ligating the artery to either side of the sac, injecting coagulating fluids, compression, galvano-puncture, expectant method, and amputation. Most cases should be treated by ligature of the artery above and below the sac; the chief dangers to be feared are hemorrhage from the artery above the sac and gangrene of the limb below the ligature.

After ligature of the brachial artery at the middle of the arm the circulation is reestablished by the anastomosis of the—

Superior profunda artery	with	the anastomotica magna, radial recurrent, and interosseous recurrent arteries,
The inferior profunda artery	with	the anastomotica magna, anterior ulnar recurrent, and posterior ulnar recurrent arteries.

After ligature of the brachial artery at the bend of the elbow the circulation is reestablished by the anastomosis of—

The superior profunda and anastomotica magna arteries	with	the radial recurrent and interosseous recurrent arteries,
The inferior profunda and anastomotica magna arteries	with	the anterior ulnar recurrent and posterior ulnar recurrent arteries.

The course of the **radial artery** in the forearm is represented by a line drawn from the middle of the bend of the elbow to the radial pulse, just to the inner

middle of the bend of the elbow. They will be found along the inner edge of the coraco-brachialis muscle, in company with the third portion of the axillary artery. The incision extends from the middle of the floor of the axilla, along the inner edge of the coraco-brachialis muscle for about three inches. The parts divided will include the skin, superficial fascia, small branches of the intercosto-humeral, internal cutaneous and lesser internal cutaneous nerves, cutaneous branches of the long thoracic artery, and of the superficial external mammary artery when present. The deep fascia is then incised, and the inner edge of the coraco-brachialis muscle exposed. The first portion of the axillary vein and the third portion of the axillary artery will next be located. The vein lies in front of the artery with the arm in this position. The median and musculo-cutaneous nerves will be found on the outer side, the ulnar nerve on the inner side of the artery, and the musculo-spiral and circumflex nerves behind the vessel. The musculo-spiral and circumflex nerves can be readily reached by drawing the coraco-brachialis muscle and the brachial artery outward. These nerves are generally stretched in the arm separately.

The course of the **ulnar nerve** in the lower part of the arm corresponds to a line drawn from a point on the inner side of the insertion of the coraco-brachialis to a point midway between the internal condyle of the humerus and the olecranon. To expose the nerve an incision should be made along its course, beginning about three inches above the internal condyle and extending to about one-half of an inch above. The skin and superficial fascia are to be divided, with branches of the internal and lesser cutaneous nerves, and small branches of the inferior profunda and anastomotica magna arteries. Next, the deep fascia should be incised, thereby exposing the internal intermuscular septum covering the inner head of the triceps muscle. Now incise the intermuscular septum, when will be seen the inferior profunda artery, which is readily located by its pulsations, and the ulnar nerve lying to the inner side of the vessel.

The **median nerve** may be stretched at any part of its course in the arm. At the bend of the elbow an incision should be made along the inner edge of the biceps muscle, beginning about on a level with the tip of the internal condyle of the humerus and extending downward for about two inches. The skin and

The point of election for exposing the **musculo-spiral nerve** is immediately above the external condyle of the humerus. The incision is made parallel with the inner margin of the supinator longus muscle. Skin and superficial fascia will be divided, with cutaneous twigs of the musculo-spiral nerve and superior profunda artery. The deep fascia is incised in the line of the original incision, and the inner border of the supinator longus muscle exposed. At the bottom of the interval between this muscle and the brachialis anticus the nerve is found. The terminal portions of the superior profunda and radial recurrent arteries are in relation with the nerve in the interval.

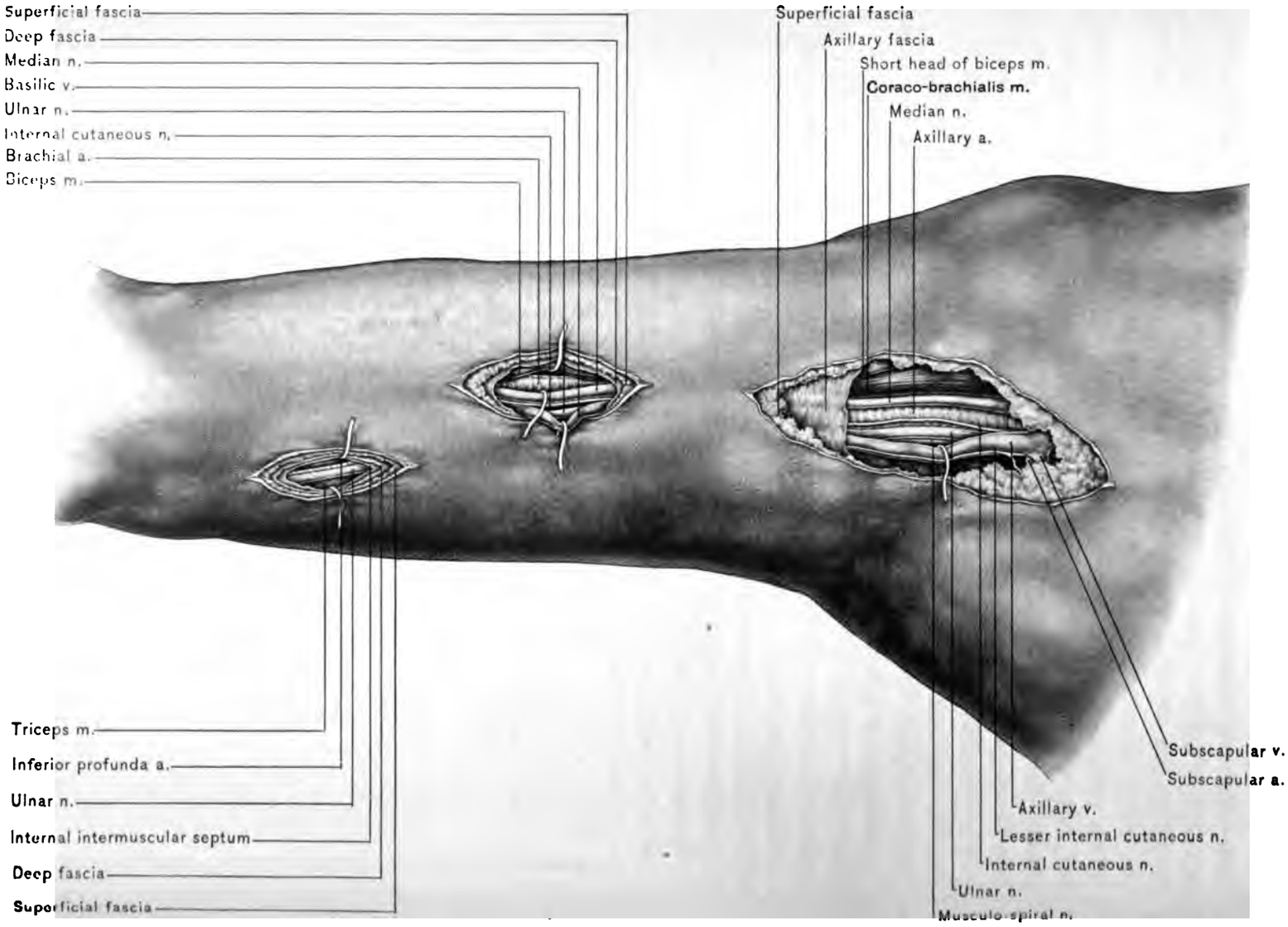
To expose the radial nerve just above the middle of the forearm, an incision should be made in the line of the radial artery—namely, from the middle of the bend of the elbow to the radial pulse. At this point the nerve will be found on the outer side of the artery; but a short distance lower down, the nerve will be seen to leave the artery and pass to the posterior aspect of the forearm by going beneath the tendon of the supinator longus muscle. The incision divides the skin, superficial fascia, twigs of the anterior branch of the musculo-cutaneous nerve and of the anterior branch of the internal cutaneous nerve, and small branches of the radial artery. The deep fascia is then incised and the supinator longus muscle exposed. The muscle is drawn outward, and the radial artery located by its pulsations. The radial nerve will be found lying along the outer side of the artery.

The **ulnar nerve** is best exposed in the forearm by an incision made immediately above the wrist, to the outer side of, and parallel with, the tendon of the flexor carpi ulnaris. The skin, superficial fascia, twigs of the anterior branch of the internal cutaneous nerve, and a few small cutaneous arteries and veins will be divided. The deep fascia is incised and the tendon of the flexor carpi ulnaris exposed. This tendon should be drawn inward, and the ulnar artery located by its pulsations. The ulnar nerve will be found to the ulnar side of the artery.

The point selected in stretching the **median nerve** in the forearm is immediately above the wrist. The incision should be made parallel with the ulnar border of the tendon of the flexor carpi radialis; or, if the palmaris longus be present, between the tendons of these muscles. The skin, superficial fascia, twigs from the

The **brachial plexus of nerves and its large branches** are stretched for the relief of epileptiform convulsions following injury of the plexus or one of its branches; in epilepsy with a definite aura beginning in the upper extremity; in paralysis agitans following a nerve injury; for the relief of pain and anesthesia in anesthetic leprosy; and for the relief of pain and spasm of the muscles resulting from a contusion or a lacerated wound which has involved a nerve. Stretching of the involved nerve or nerves is not certain to afford permanent relief in any case, but the operation is more satisfactory in cases of irritation or sclerosis of the nerve from contusion or involvement of a lacerated wound in scar tissue.

Irritation of the *circumflex nerve* causes spasm of the deltoid and teres minor muscles, and pain over the deltoid and upper part of the triceps muscle. Irritation of the *musculo-spiral nerve* produces spasm of the triceps muscle, radial extensors, superficial extensors, and deep extensors, and pain in the back of the arm, outer side of the arm and forearm, radial side of the back of the hand, and in the dorsal surface of the thumb, of the index finger, of the middle finger, and of the radial side of the ring finger. Irritation of the *median nerve* causes spasm of the pronator radii teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum, flexor longus pollicis, radial side of flexor profundus digitorum, pronator quadratus, abductor pollicis, opponens pollicis, outer head of flexor brevis pollicis, and the two radial lumbricales muscles, and pain in the front of the wrist, palm of the hand, and anterior surface of the thumb, of the index finger, of the middle finger, of the radial side of the ring finger, and in the back of the middle finger over the two distal phalanges. Irritation of the *ulnar nerve* causes spasm of the flexor carpi ulnaris, ulnar side of flexor profundus digitorum, palmaris brevis, muscles of the hypothenar eminence, the two ulnar lumbricales, interossei muscles, adductor pollicis, and the inner head of the flexor brevis pollicis muscle, and pain


Superficial fascia
Deep fascia
Median n.
Basilic v.
Ulnar n.
Internal cutaneous n.
Brachial a.
Biceps m.
Superficial fascia
Axillary fascia
Short head of biceps m.
Coraco-brachialis m.
Median n.
Axillary a.
Triceps m.
Inferior profunda a.
Ulnar n.
Internal intermuscular septum
Deep fascia
Superficial fascia
Subscapular v.
Subscapular a.
Axillary v.
Lesser internal cutaneous n.
Internal cutaneous n.
Ulnar n.
Musculo-spiral n.

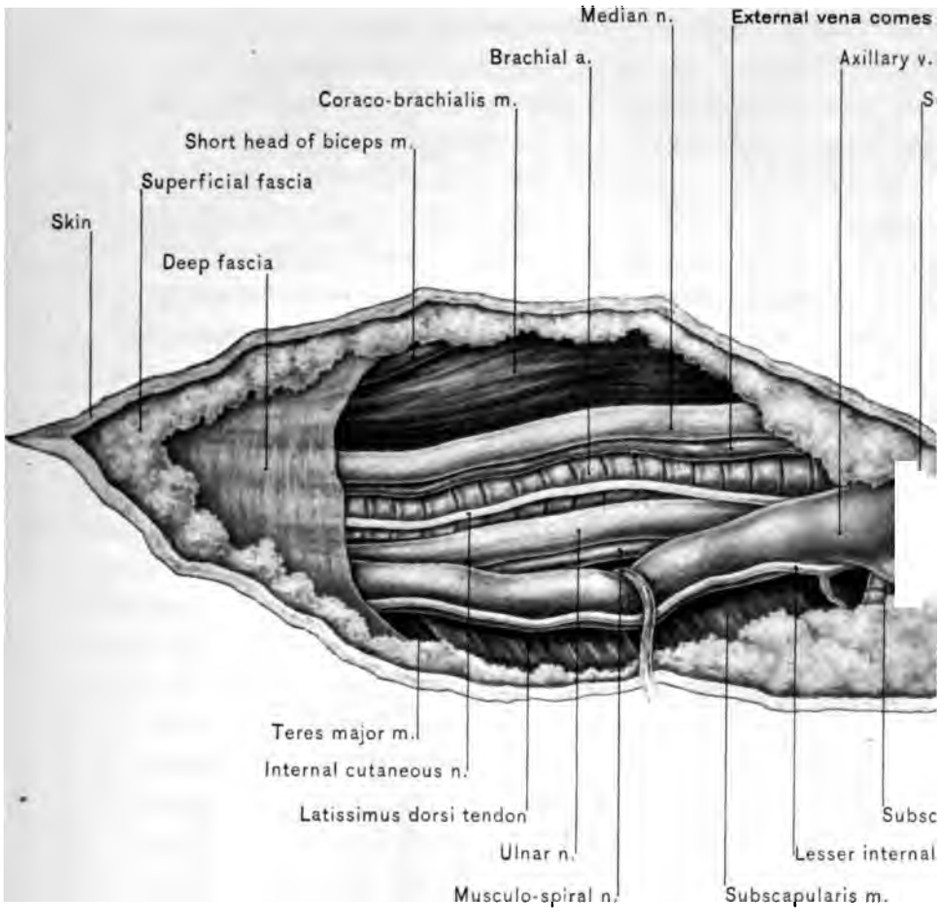
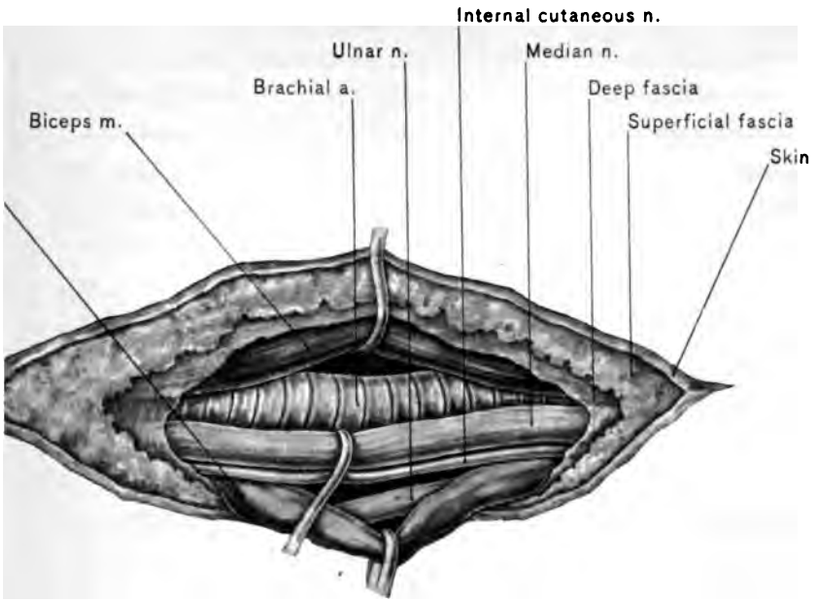
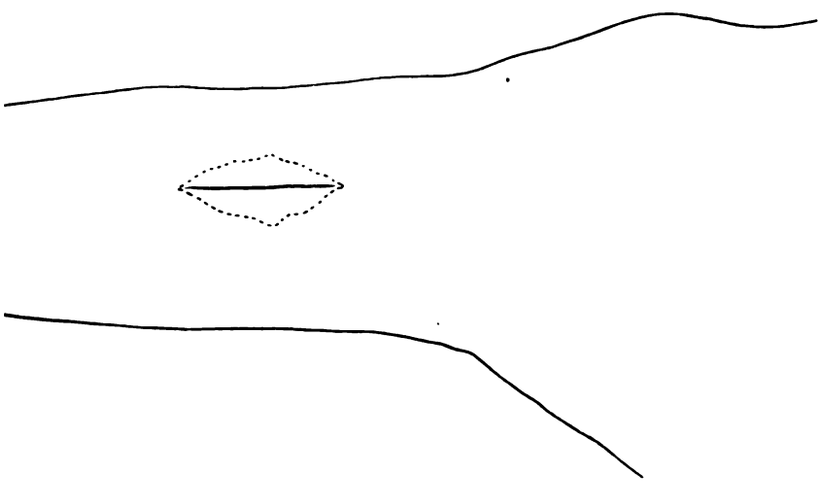
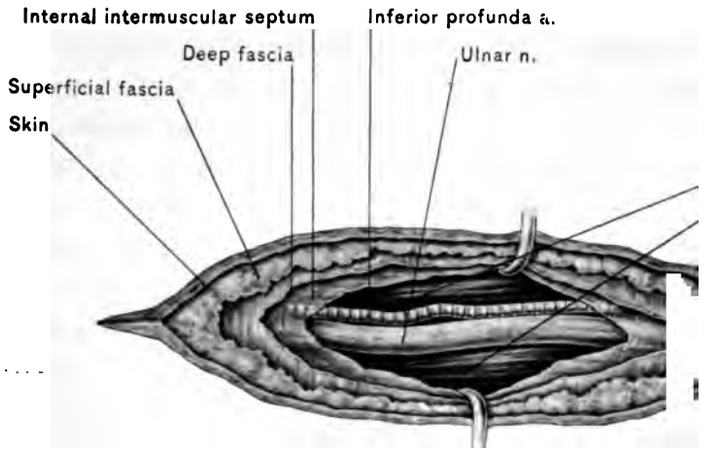
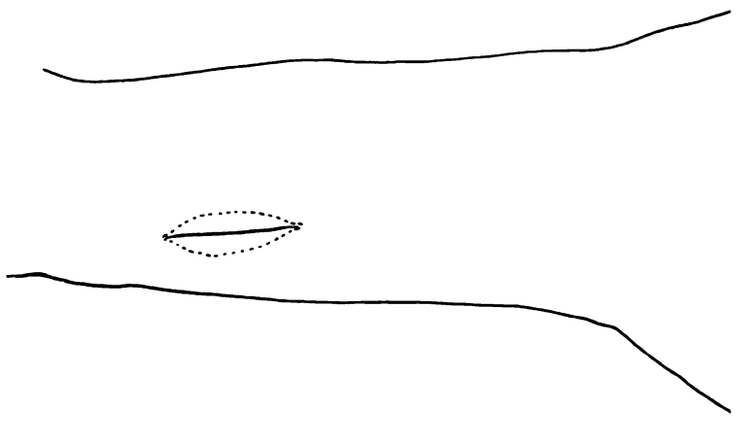

Median n.
External vena comes
Brachial a.
Axillary v.
Coraco-brachialis m.
Short head of biceps m.
Superficial fascia
Skin
Deep fascia
Teres major m.
Internal cutaneous n.
Latissimus dorsi tendon
Ulnar n.
Musculo-spiral n.
Subscapularis m.
Lesser internal

PLATE I


Internal cutaneous n.
Ulnar n.
Median n.
Brachial a.
Deep fascia
Biceps m.
Superficial fascia
Skin




Internal intermuscular septum
Inferior profunda a.
Deep fascia
Ulnar n.
Superficial fascia
Skin



middle of the bend of the elbow. They will be found along the inner edge of the coraco-brachialis muscle, in company with the third portion of the axillary artery. The incision extends from the middle of the floor of the axilla, along the inner edge of the coraco-brachialis muscle for about three inches. The parts divided will include the skin, superficial fascia, small branches of the intercosto-humeral, internal cutaneous and lesser internal cutaneous nerves, cutaneous branches of the long thoracic artery, and of the superficial external mammary artery when present. The deep fascia is then incised, and the inner edge of the coraco-brachialis muscle exposed. The first portion of the axillary vein and the third portion of the axillary artery will next be located. The vein lies in front of the artery with the arm in this position. The median and musculo-cutaneous nerves will be found on the outer side, the ulnar nerve on the inner side of the artery, and the musculo-spiral and circumflex nerves behind the vessel. The musculo-spiral and circumflex nerves can be readily reached by drawing the coraco-brachialis muscle and the brachial artery outward. These nerves are generally stretched in the arm separately.

The course of the **ulnar nerve** in the lower part of the arm corresponds to a line drawn from a point on the inner side of the insertion of the coraco-brachialis to a point midway between the internal condyle of the humerus and the olecranon. To expose the nerve an incision should be made along its course, beginning about three inches above the internal condyle and extending to about one-half of an inch above. The skin and superficial fascia are to be divided, with branches of the internal and lesser cutaneous nerves, and small branches of the inferior profunda and anastomotica magna arteries. Next, the deep fascia should be incised, thereby exposing the internal intermuscular septum covering the inner head of the triceps muscle. Now incise the intermuscular septum, when will be seen the inferior profunda artery, which is readily located by its pulsations, and the ulnar nerve lying to the inner side of the vessel.

The **median nerve** may be stretched at any part of its course in the arm.

The point of election for exposing the **musculo-spiral nerve** is immediately above the external condyle of the humerus. The incision is made parallel with the inner margin of the supinator longus muscle. Skin and superficial fascia will be divided, with cutaneous twigs of the musculo-spiral nerve and superior profunda artery. The deep fascia is incised in the line of the original incision, and the inner border of the supinator longus muscle exposed. At the bottom of the interval between this muscle and the brachialis anticus the nerve is found. The terminal portions of the superior profunda and radial recurrent arteries are in relation with the nerve in the interval.

To expose the radial nerve just above the middle of the forearm, an incision should be made in the line of the radial artery—namely, from the middle of the bend of the elbow to the radial pulse. At this point the nerve will be found on the outer side of the artery; but a short distance lower down, the nerve will be seen to leave the artery and pass to the posterior aspect of the forearm by going beneath the tendon of the supinator longus muscle. The incision divides the skin, superficial fascia, twigs of the anterior branch of the musculo-cutaneous nerve and of the anterior branch of the internal cutaneous nerve, and small branches of the radial artery. The deep fascia is then incised and the supinator longus muscle exposed. The muscle is drawn outward, and the radial artery located by its pulsations. The radial nerve will be found lying along the outer side of the artery.

The **ulnar nerve** is best exposed in the forearm by an incision made immediately above the wrist, to the outer side of, and parallel with, the tendon of the flexor carpi ulnaris. The skin, superficial fascia, twigs of the anterior branch of the internal cutaneous nerve, and a few small cutaneous arteries and veins will be divided. The deep fascia is incised and the tendon of the flexor carpi ulnaris exposed. This tendon should be drawn inward, and the ulnar artery located by its pulsations. The ulnar nerve will be found to the ulnar side of the artery.

The point selected in stretching the **median nerve** in the forearm is immediately above the wrist. The incision should be made parallel with the ulnar border of the tendon of the flexor carpi radialis; or, if the palmaris longus be present, between the tendons of these muscles. The skin, superficial fascia, twigs from the anterior branch of the internal cutaneous nerve, and a few small cutaneous arteries and veins will be divided. The deep fascia is incised and the tendon of the flexor carpi radialis exposed. This tendon should be drawn outward, when the nerve will be seen between the superficial and deep set of flexor tendons, to the radial side of the outermost tendon of the flexor sublimis digitorum. The median

PLATE LXXXII.

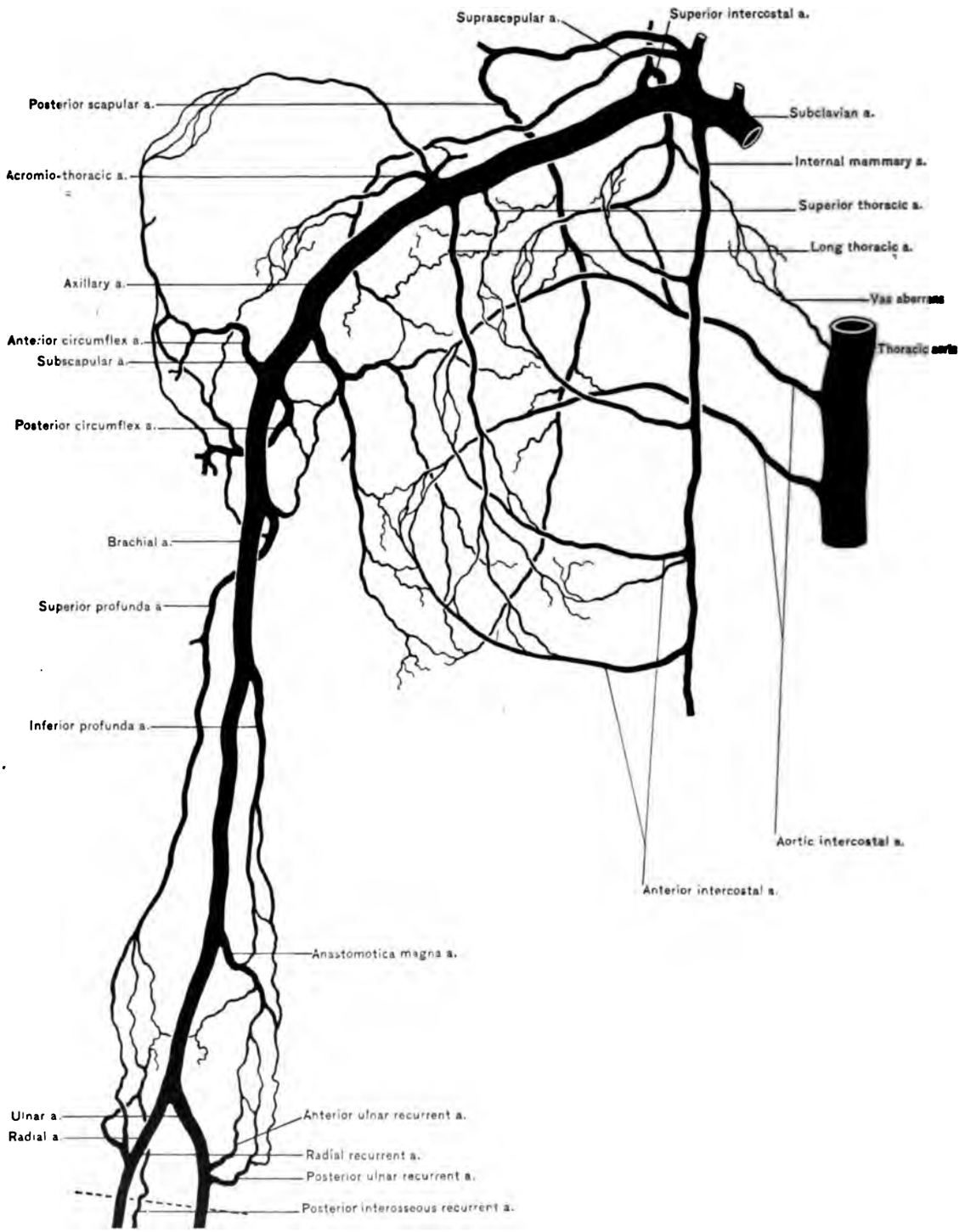


PLATE LXXXIII

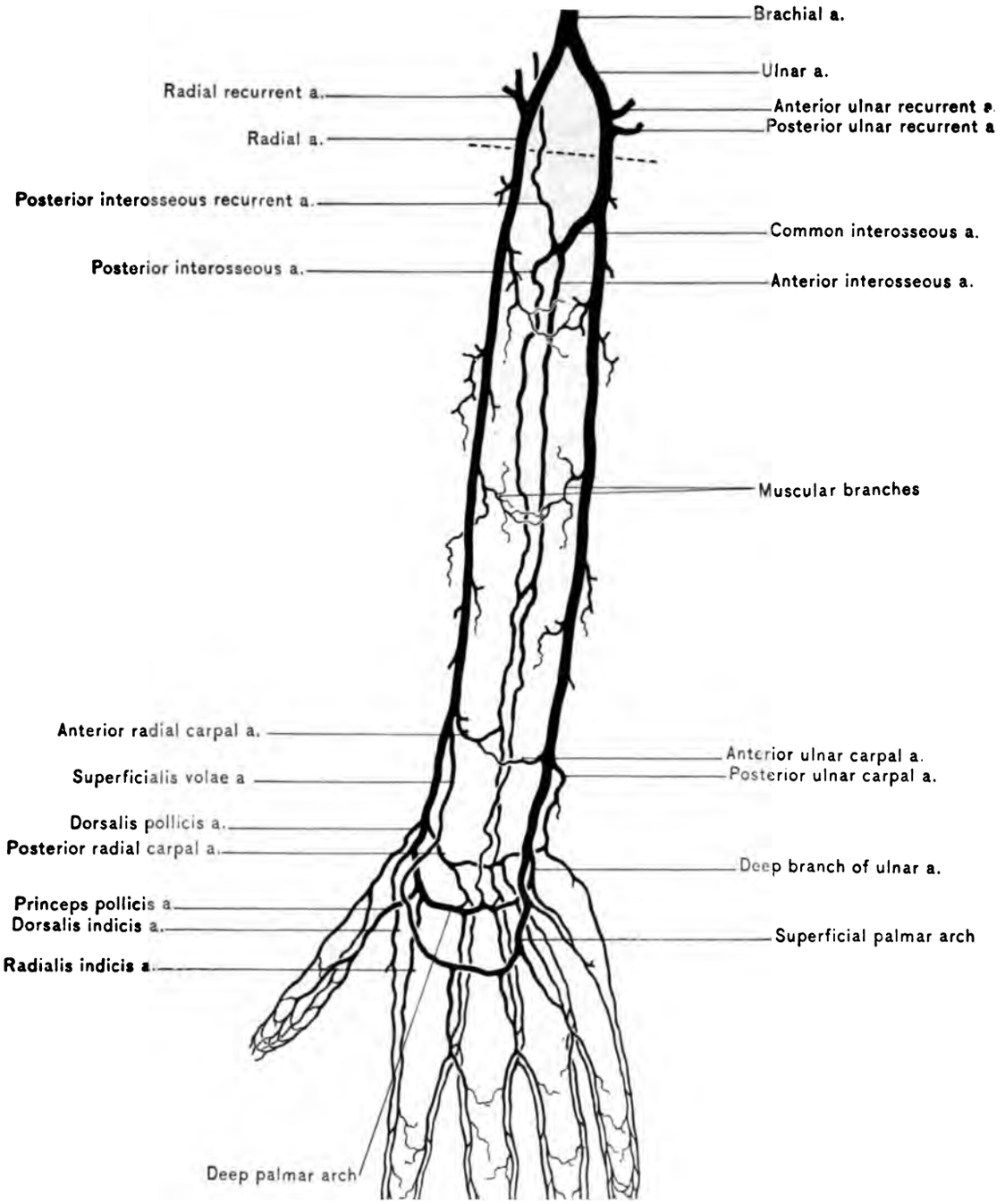


PLATE LXXXIV.

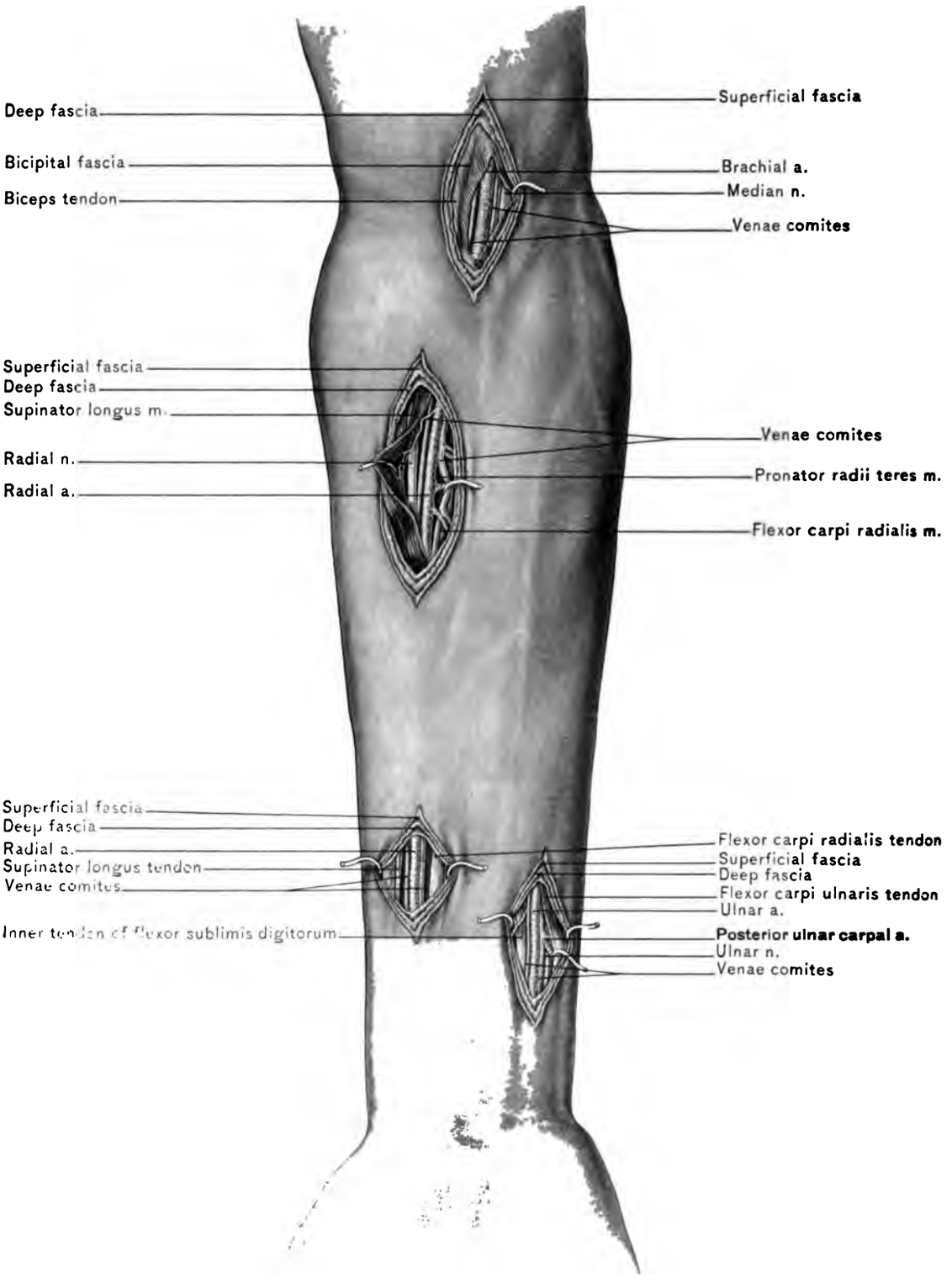
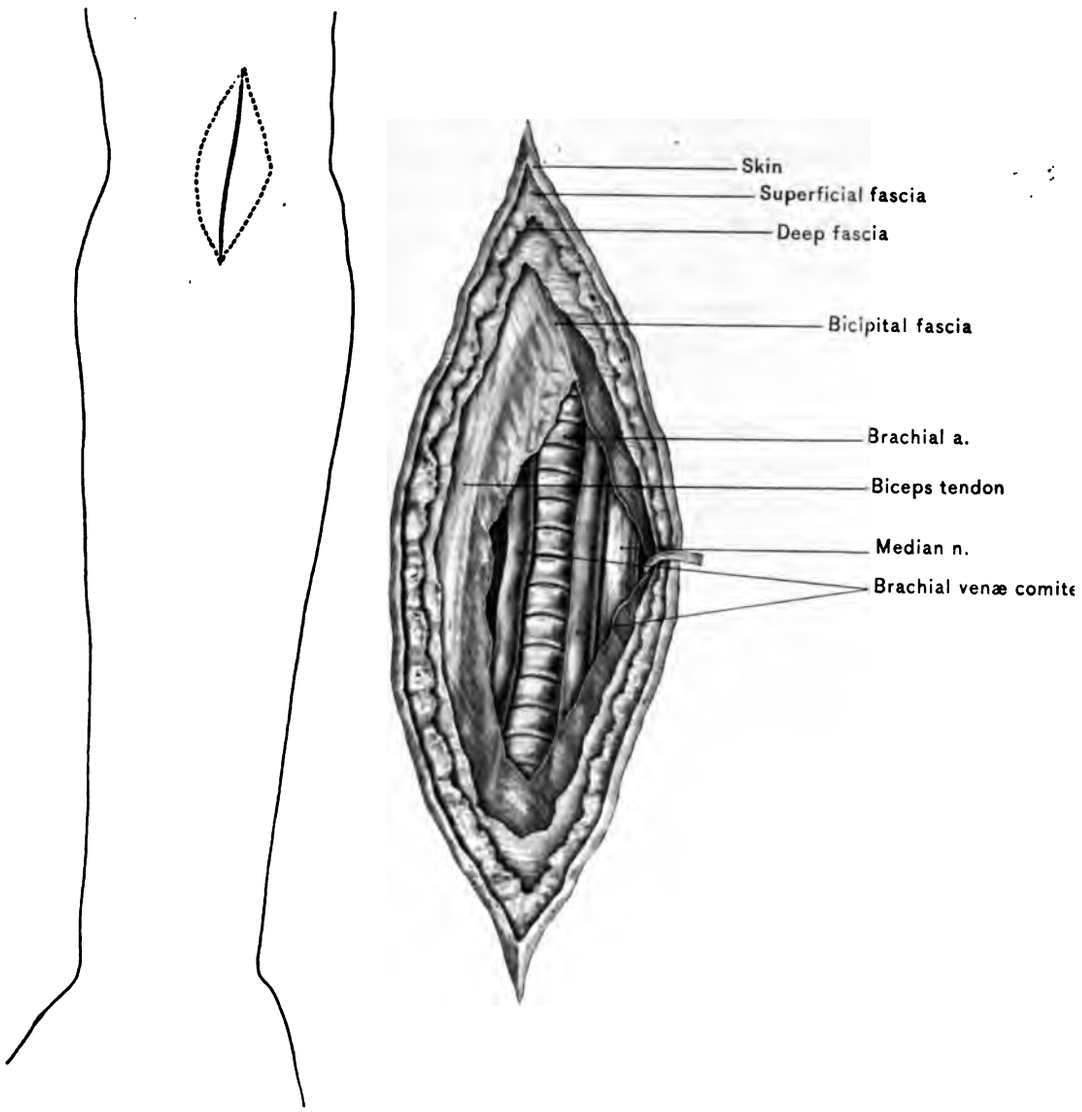


PLATE LX


Skin
Superficial fascia
Deep fascia
Bicipital fascia
Brachial a.
Biceps tendon
Median n.
Brachial venæ comite

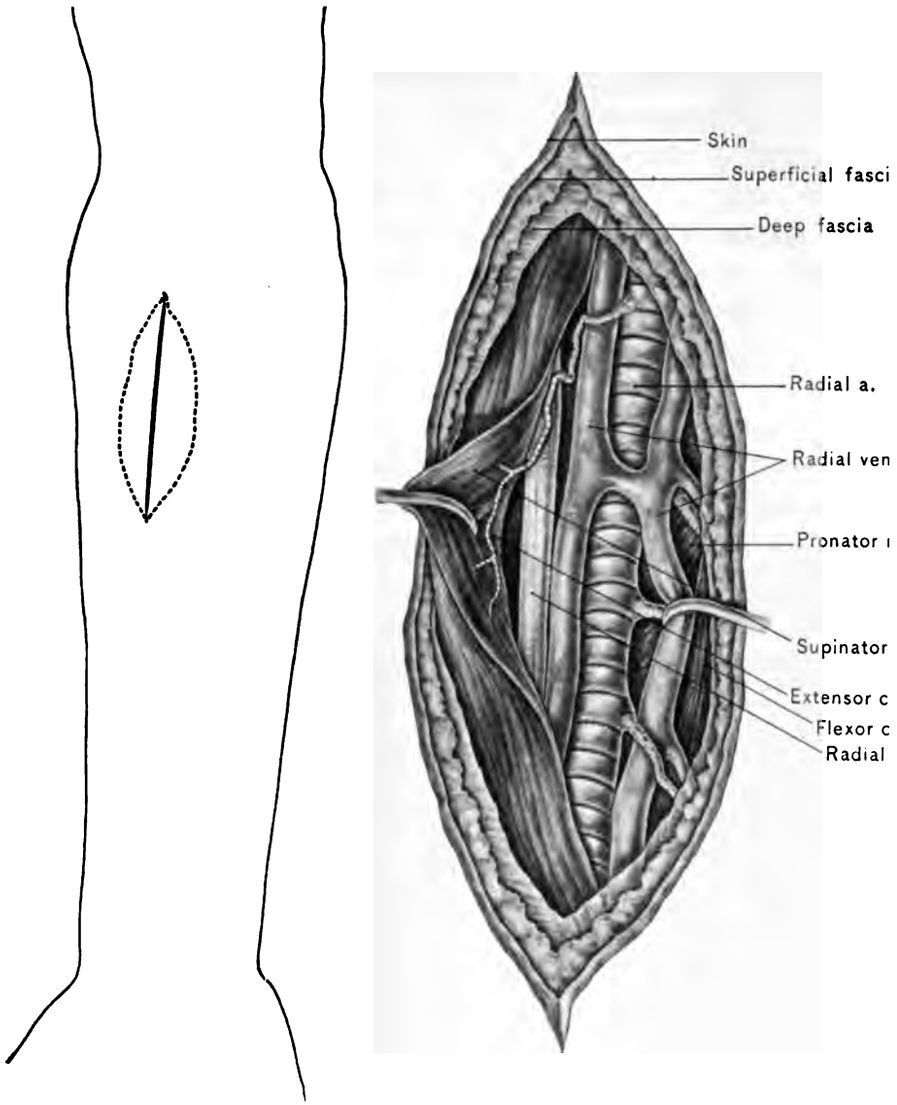

Skin
Superficial fasci
Deep fascia
Radial a.
Radial ven
Pronator r
Supinator
Extensor c
Flexor c
Radial

PLATE LXXXVI

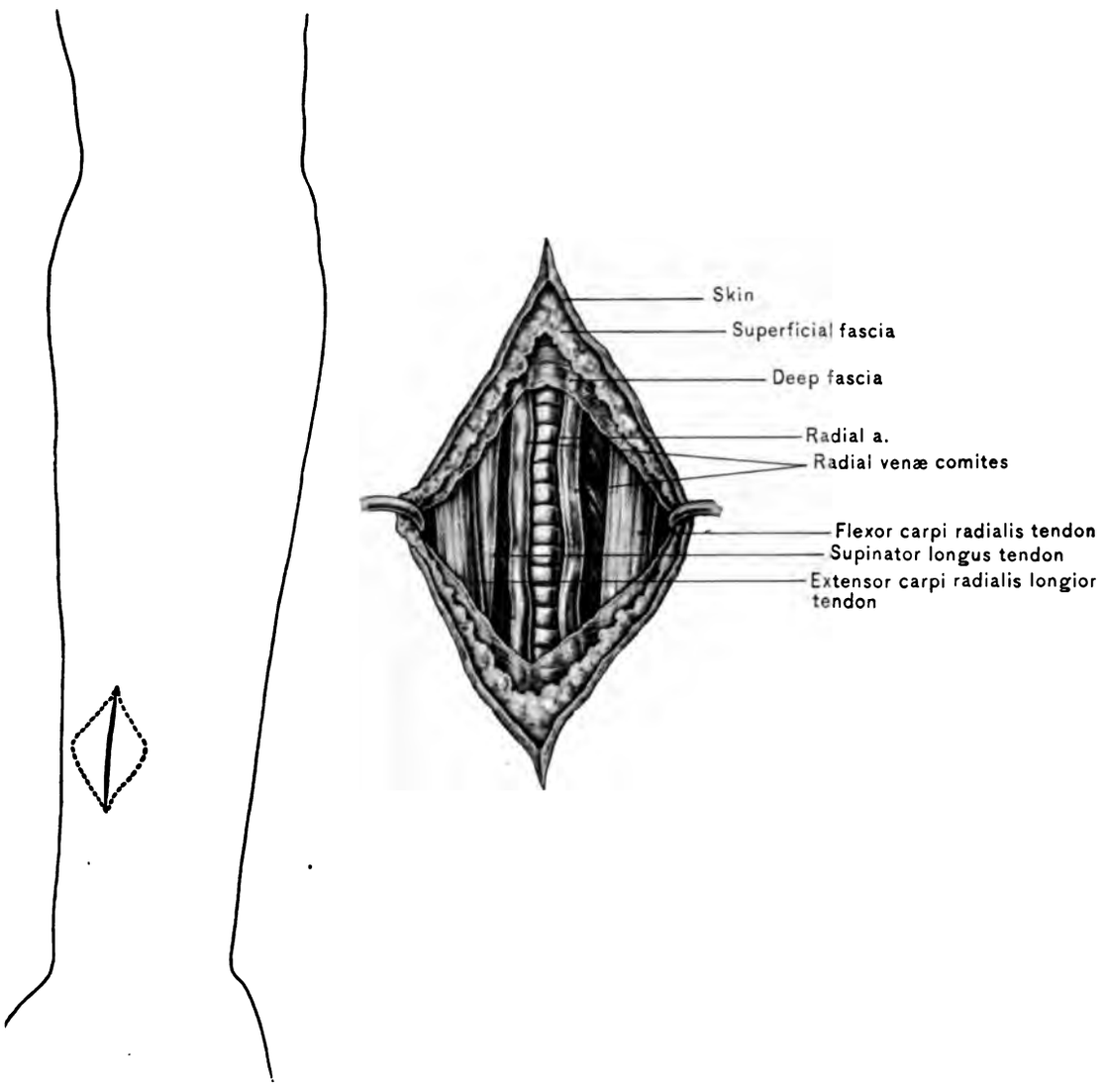
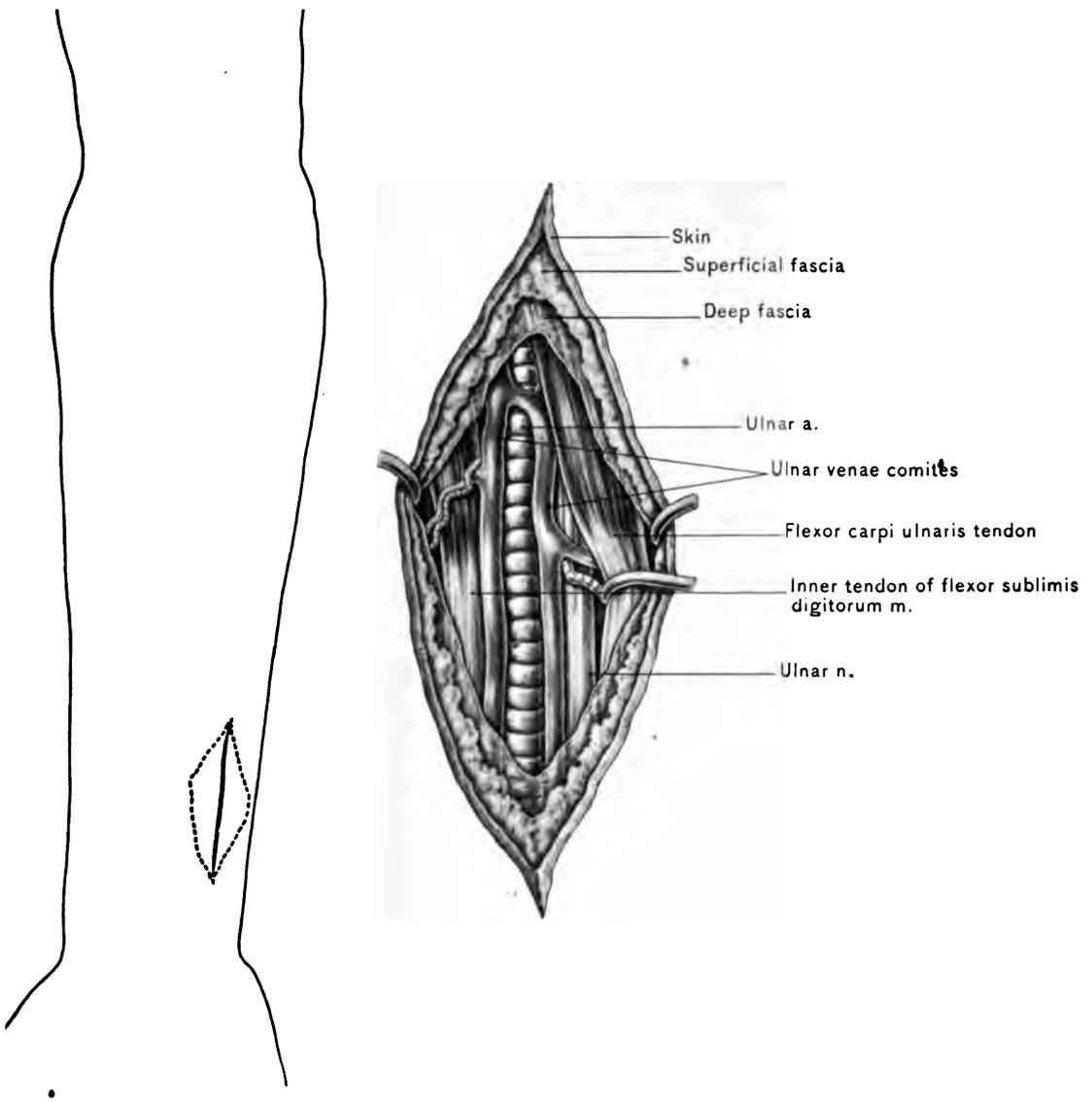
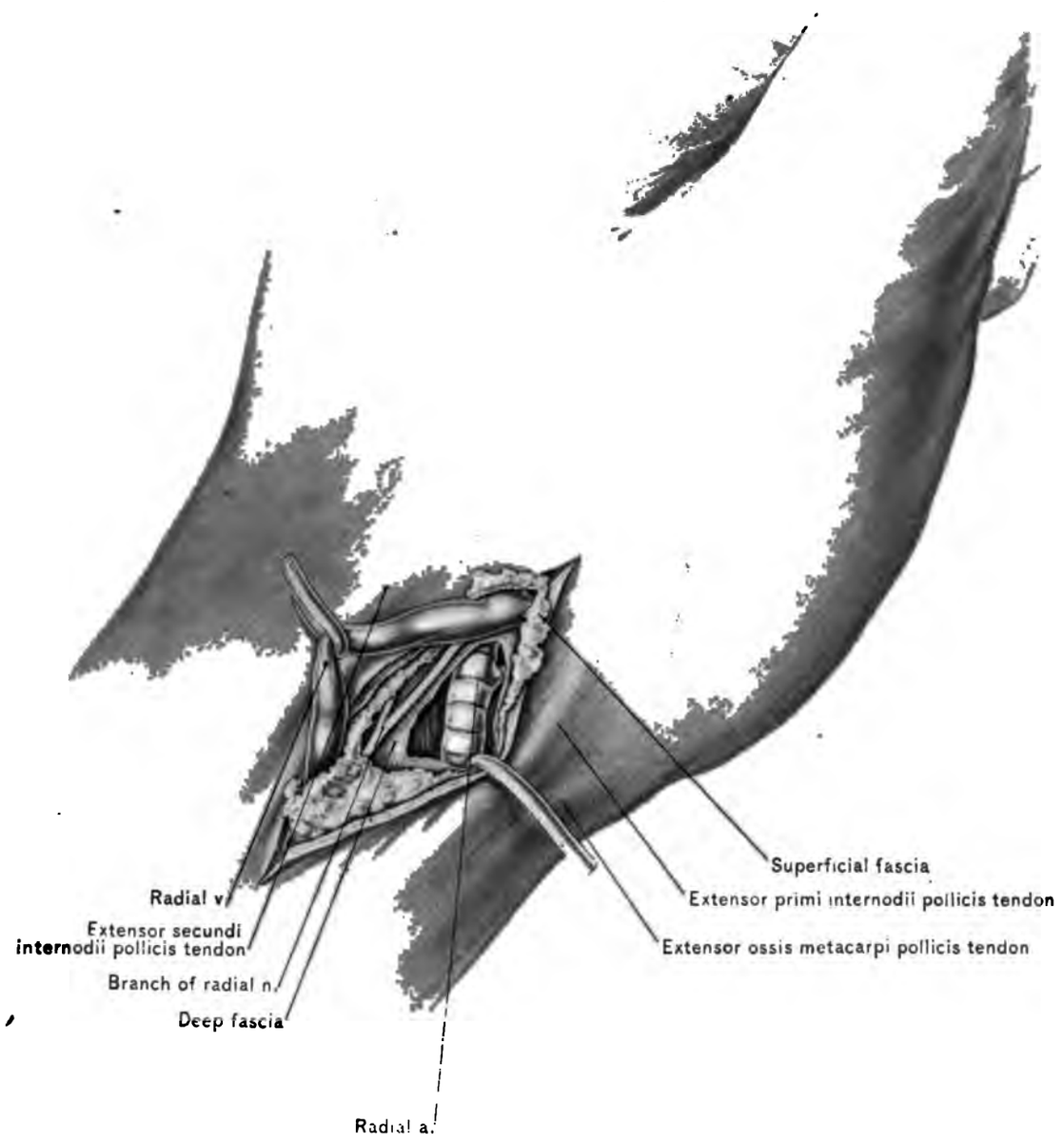


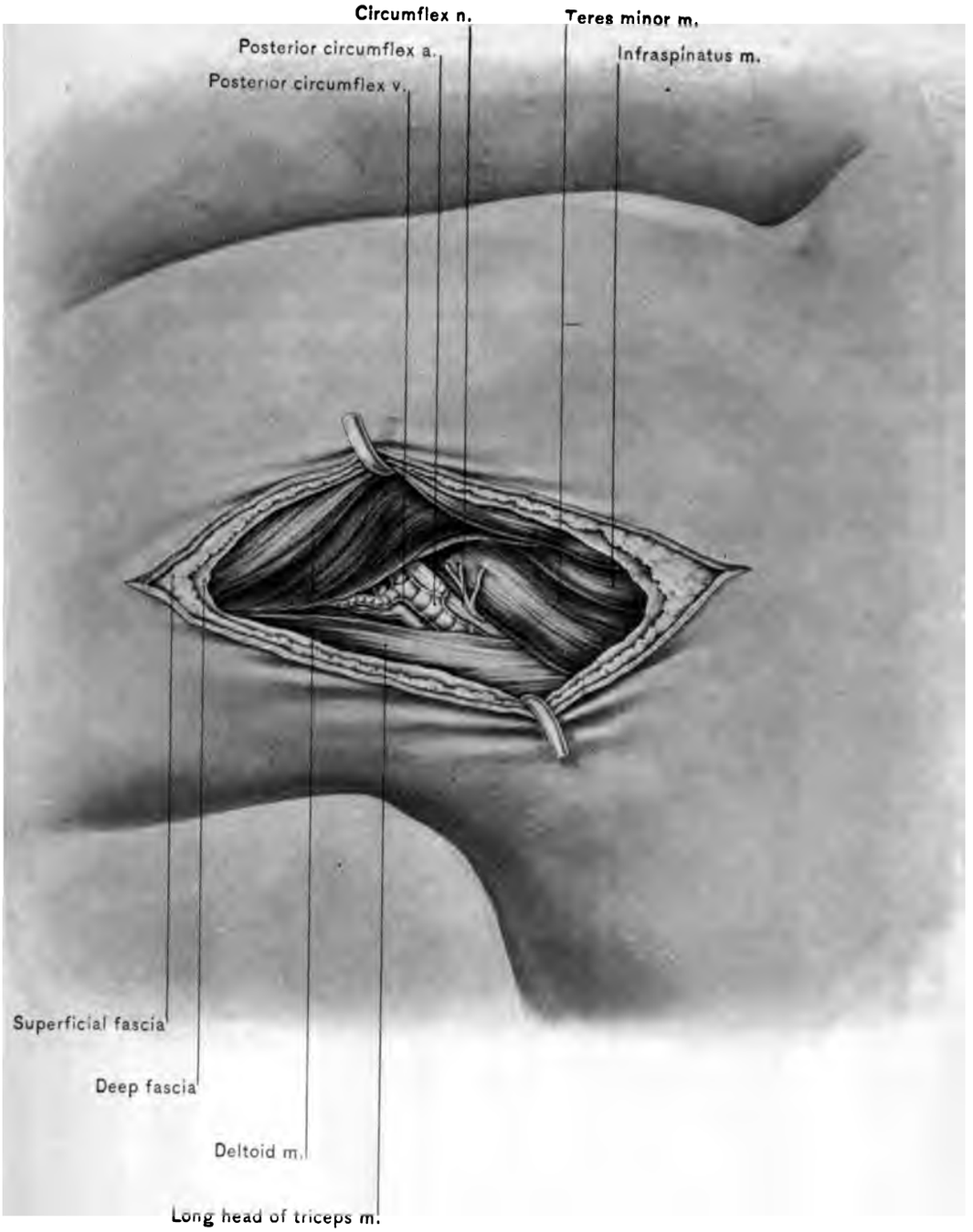
PLATE LXXXVIII.

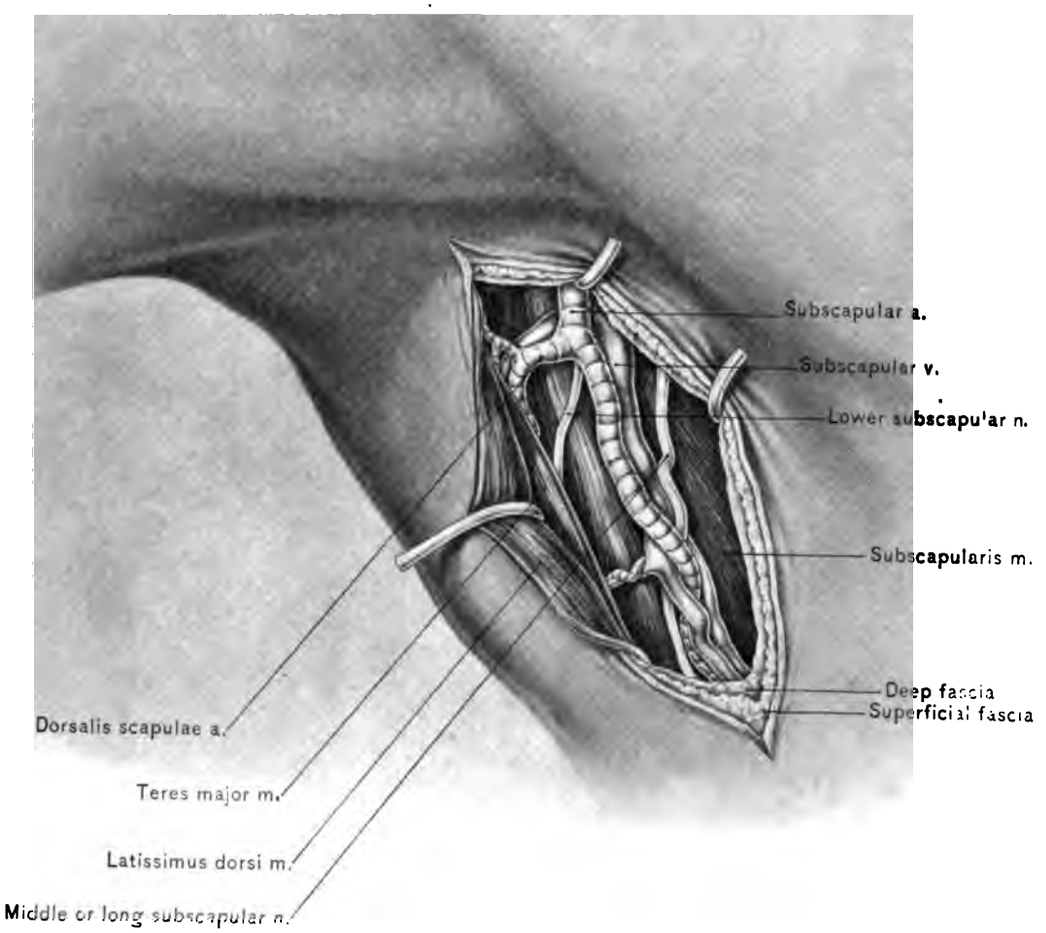


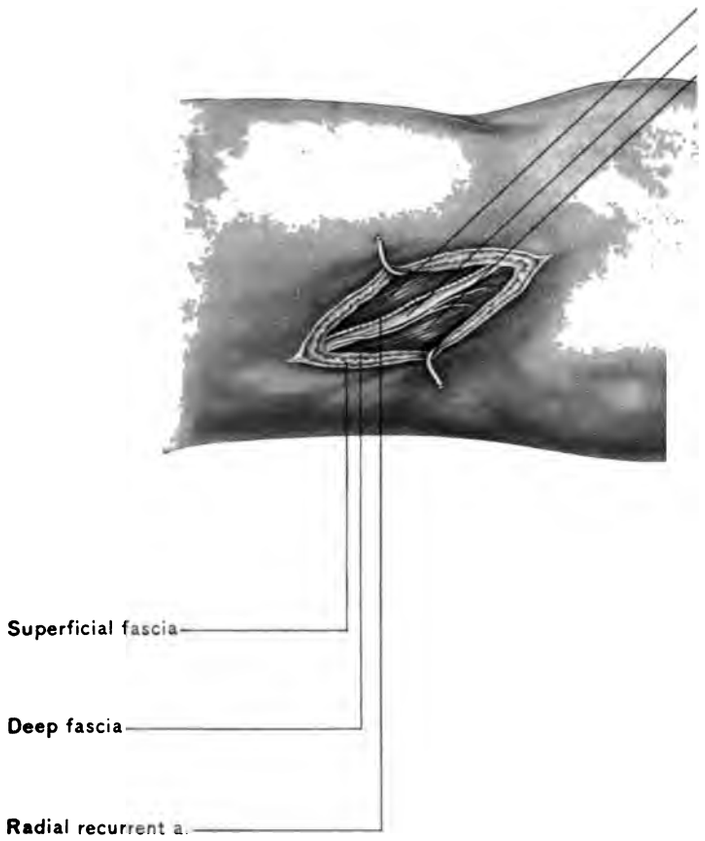
Extensc
Exti
L
Exten

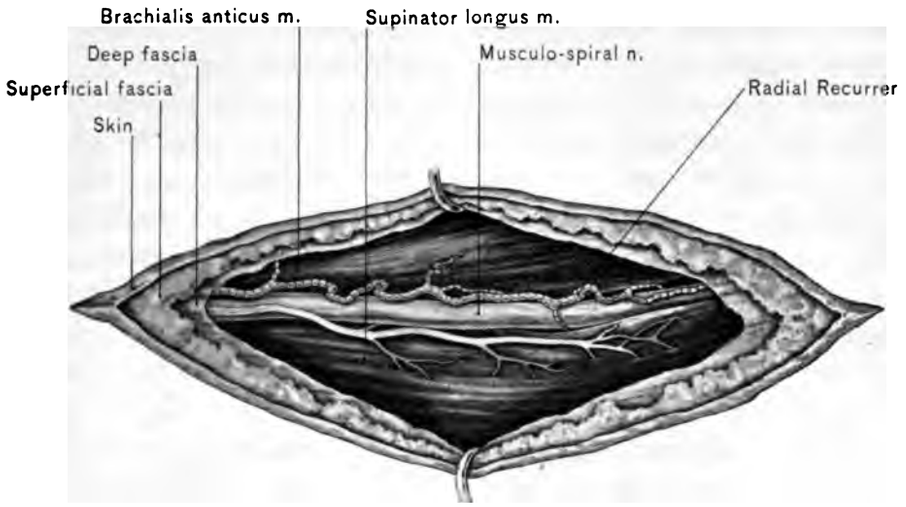
PLATE XC


Superficial fascia
Extensor primi internodii pollicis tendon
Extensor ossis metacarpi pollicis tendon
Radial v.
Extensor secundi internodii pollicis tendon
Branch of radial n.
Deep fascia
Radial a.


Circumflex n.
Teres minor m.
Posterior circumflex a.
Infraspinatus m.
Posterior circumflex v.
Superficial fascia
Deep fascia
Deltoid m.
Long head of triceps m.


Subscapular a.
Subscapular v.
Lower subscapular n.
Subscapularis m.
Deep fascia
Superficial fascia
Dorsalis scapulae a.
Teres major m.
Latissimus dorsi m.
Middle or long subscapular n.


Superficial fascia
Deep fascia
Radial recurrent a.


Brachialis anticus m.
Supinator longus m.
Deep fascia
Musculo-spiral n.
Superficial fascia
Radial Recurrer
Skin

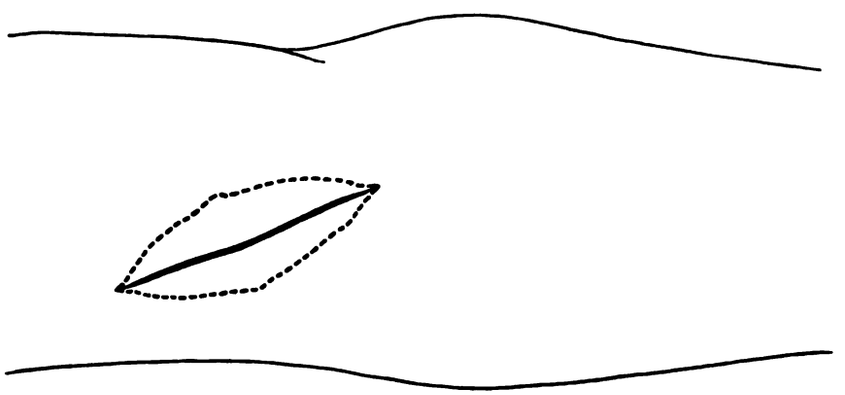
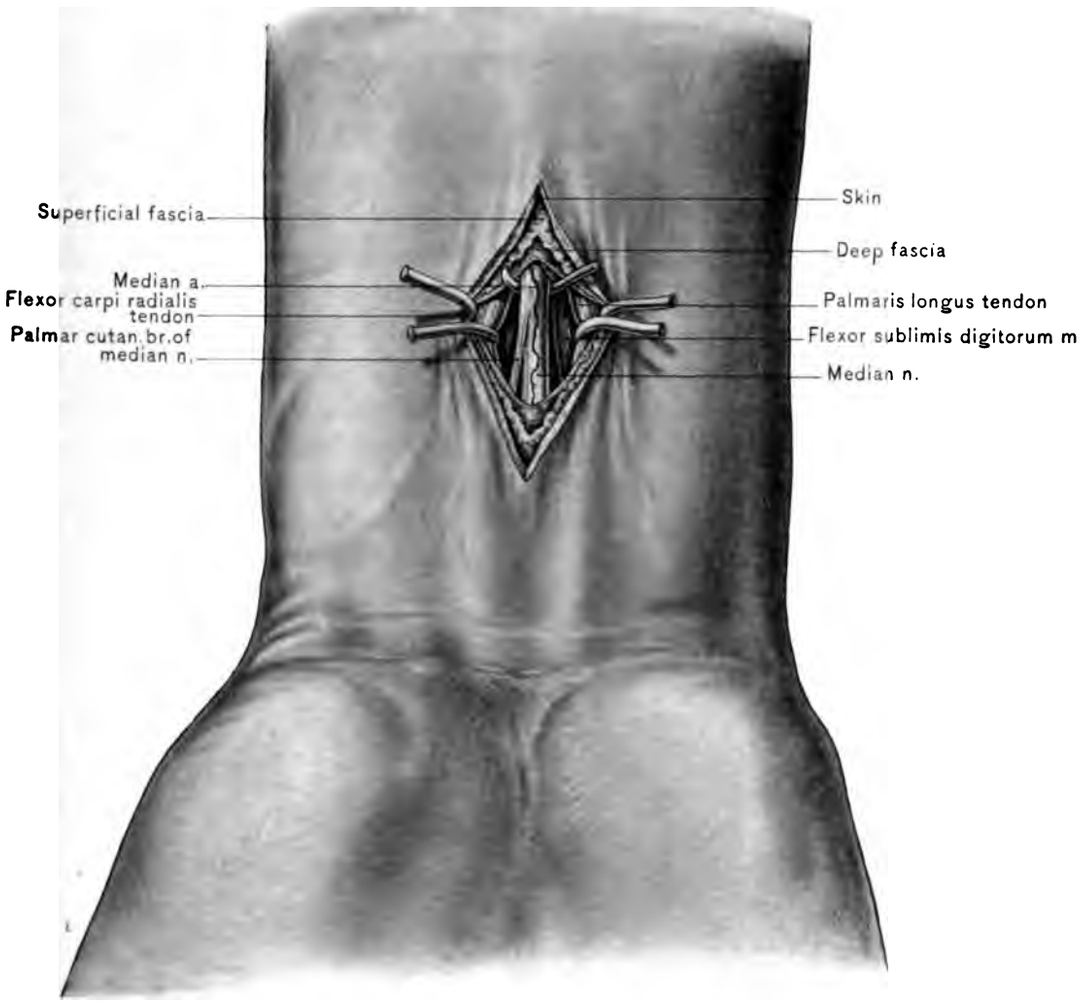


PLATE XC


Superficial fascia
Median a.
Flexor carpi radialis tendon
Palmar cutan. br. of median n.
Skin
Deep fascia
Palmaris longus tendon
Flexor sublimis digitorum m
Median n.

THE BACK OF THE NECK, SHOULDER, AND TRUNK.

Surface anatomy.—In the middle line, extending from the external occipital protuberance to the sacrum, is a longitudinal furrow, especially well pronounced in muscular subjects in the dorsal and lumbar regions. At the back of the neck it is called the *nuchal*, and below that point the *spinal, furrow.* It is produced by the presence of large muscular masses upon each side of the median line, and by the close adherence of the fasciæ to the ligamentum nuchæ and the supra-spinous ligaments. In the neck and dorsal region this groove lies between the trapezius muscles, and in the lumbar locality between the erector spinæ muscles. The spinal furrow is deepest in the lower dorsal and the upper lumbar region and, as it descends toward the sacrum, where the erector spinæ muscles are more tendinous, gradually fades away. A little above and external to the last spinous process of the sacrum (third sacral spine) is a depression which marks the position of the posterior superior spine of the ilium. At the bottom of the nuchal furrow the bifid spine of the axis, and less distinctly the spines of the third, fourth, and fifth cervical vertebræ, may be felt. The spines of the sixth and seventh cervical vertebræ stand out prominently. At the bottom of the spinal furrow the spinous processes of the dorsal, lumbar, and sacral vertebræ may be readily distinguished; they become more pronounced when the body is bent forward.

The **scapula** can be outlined at the back of the shoulder with facility in thin persons and with difficulty in obese persons. The vertebral border of the bone is felt at the side of the spinal furrow, and with the arm at the side of the body is parallel with the spinous processes of the vertebræ. During abduction of the arm, the inferior angle of the scapula glides forward and the vertebral border makes an increasing angle with the spinous processes of the vertebræ. The axillary border is indistinctly felt, and the superior border can not be palpated through the overlying muscles. When the arms are hanging by the side, the superior angle of the scapula is opposite the upper margin of the second rib, and the inferior angle overlies the seventh intercostal space. The inferior angle is a guide in the operations of aspiration or drainage of the pleural sac, which are performed in the fifth or sixth intercostal space at the side of the thorax. The spinous and acromion processes of the scapulæ are subcutaneous and readily palpated, so that fractures of these processes are detected more easily than fractures of other portions of the

the external condyle of the humerus and the styloid process of the radius, or the internal condyle of the humerus and the styloid process of the ulna.

Over the inner end of the spine of the scapula is a depression which marks the position of the flat, triangular tendon, into which the lower fibers of the trapezius muscle are inserted. Above the spine of this bone, extending to the sloping surface of the shoulder, is a rounded elevation, produced by the trapezius resting upon the levator anguli scapulæ and supra-spinatus muscles.

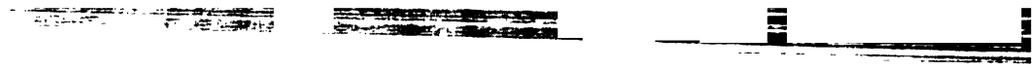
When the patient is sitting and his arms hang between his thighs so as to depress the scapulæ, the spines of those bones are almost opposite the fissures between the upper and lower lobes of the lungs. The location of these fissures is of importance in the diagnosis of lobar pneumonia.

The lower ribs can be felt at the back of the trunk, external to the erector spinæ muscle. As the twelfth rib does not always extend beyond the outer margin of the erector spinæ muscle, the ribs should be counted from above downward. Just below the last rib and external to the erector spinæ muscle the kidney can be palpated and subjected to pressure.

In percussion or auscultation at the back of the chest, the patient should cross his arms and lean forward so that the scapulæ will be carried forward, and uncover as much of the posterior surface of the chest as possible. Because of the presence of thick masses of muscular tissue in the vertebral grooves, there is at all levels dullness on percussion close to the spinous processes of the vertebræ.

The spines of the vertebræ lie in a straight line, and the spinal column presents no lateral curves. The back, like the spinal column, contains four antero-posterior curves—the cervical, thoracic, lumbar, and pelvic. The cervical curve of the spinal column is convex forward, the thoracic curve concave forward, the lumbar curve convex forward, and the pelvic curve, which is formed by the sacrum and coccyx, concave forward. As seen in viewing the surface of the back, the cervical curve is concave backward, the thoracic convex backward, the

PLATE XCVI.



backward; in persons who, from spinal caries, have angular forward curvature of the upper part of the thoracic region of the spine and are compelled to increase the curve of the lumbar spine on account of the advanced position of the head and shoulders; in pregnant women, and in obese persons.

Lateral curvature of the spinal column in children is caused by sitting in one position for a long time; by an unequal length of the lower extremities, which causes lateral inclination of the pelvis, and by empyema. Lateral curvature of the spinal column from malposition is most common in girls who have less exercise than boys and who are, therefore, more easily tired. If such a child sit for a long time upon a seat not well designed for comfort, or at a desk which is not of the proper height, the muscles of the back become tired, and the child curves the back so that the weight will be supported by the spinal column without much assistance from the muscles. By taking the child from school and giving her plenty of muscular exercise, massage, and gymnastics, and avoiding uncomfortable positions, the condition is corrected. If the lateral curvature be produced by a short leg, a thick sole on the shoe of that leg will correct the deformity of the spinal column. The most common condition which causes shortening of one leg is hip disease. Nature tilts the pelvis to compensate for the shortness of the affected limb, and laterally curves the spinal column so that equilibrium may be maintained. When one lung is permanently collapsed as a result of empyema, the pulmonary space of that side is diminished, the ribs fall together, and the thoracic portion of the spinal column is curved. Curvature of the thoracic portion necessitates compensatory curvature of the lumbar portion of the spinal column. The concavity of the thoracic and the convexity of the lumbar curvature are directed toward the affected side. In the most common form of lateral curvature the thoracic region of the spinal column is deflected to the right and the lumbar region to the left. A line drawn along the

column is sharply curved forward and the spinous processes of the involved vertebræ project backward.

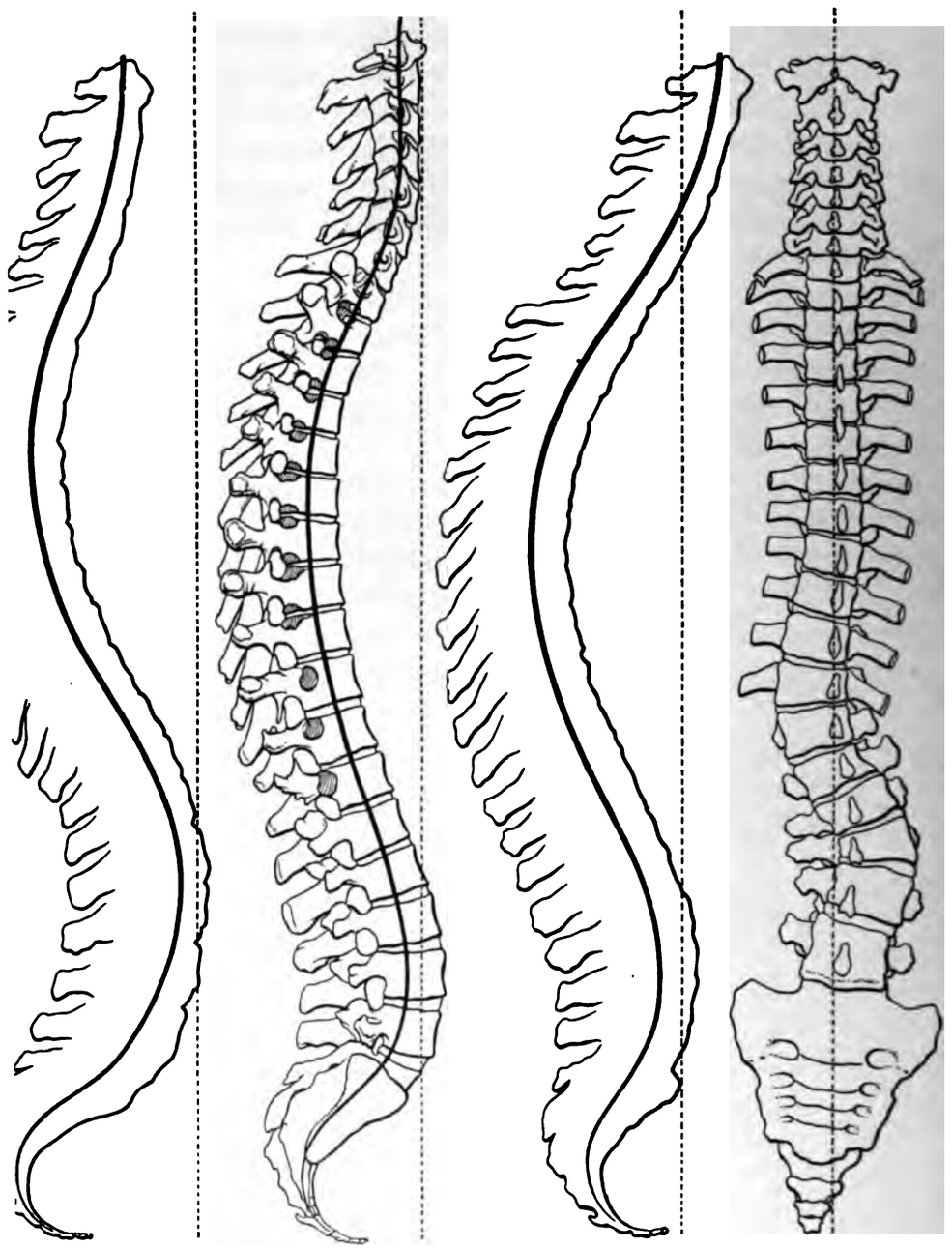
When caries of the vertebræ is rapidly progressing, **abscess formation** occurs. These pus collections are called cold abscesses because they are not associated with heat and redness.

In **disease of the cervical vertebræ** the pus accumulates behind the prevertebral fascia and the pharynx, forming a retro-pharyngeal abscess, which causes bulging in the posterior pharyngeal wall, and difficulty in respiration and deglutition. It may rupture into the pharynx, gravitate to the posterior mediastinum, or burrow outward to the posterior triangle of the neck, and even enter the axilla.

In **caries of the dorsal vertebræ** the pus usually gravitates to the diaphragm, passes under the internal arcuate ligament and the psoas fascia, and becomes a **psoas abscess**; or it burrows under the external arcuate ligament and the anterior lamella of the lumbar fascia, and forms a **lumbar abscess.** The pus may, however, ulcerate backward between the ribs, and cause a swelling in the back; or it may follow the ribs and intercostal muscles forward, and produce a swelling at the side or front of the chest. Rarely, one of these abscesses may rupture into the esophagus, pleura, lung, or pericardium.

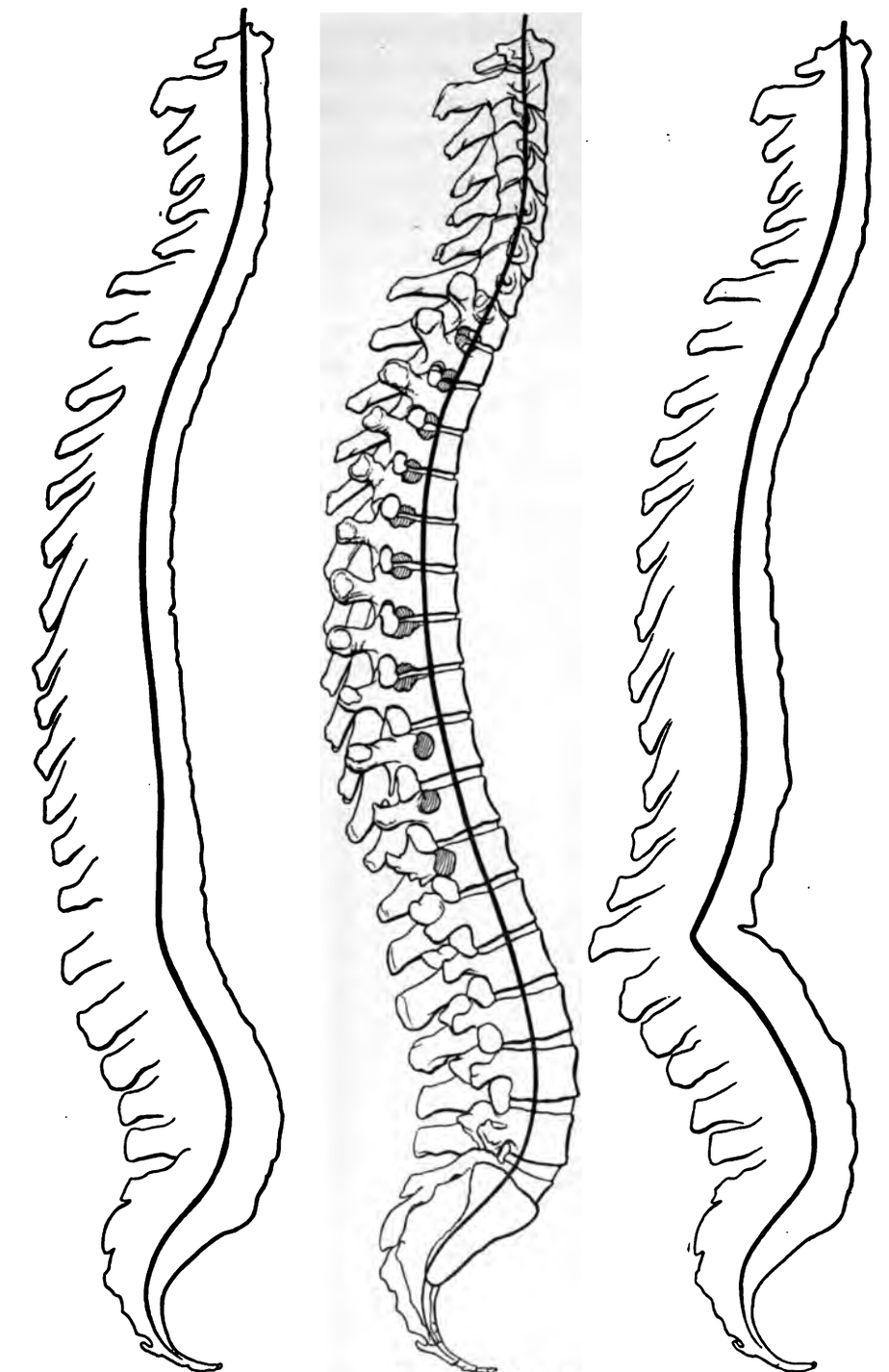
In **caries of the lumbar vertebræ** the pus usually enters the sheath of the psoas muscle, and forms a **psoas abscess.** It gravitates downward under the psoas division of the iliac fascia. After passing under Poupart's ligament it produces a swelling at the outer side of the femoral sheath, where the psoas and the iliacus muscles approach the surface, from a common tendon, and occupy a common fascial compartment. These abscesses may, however, ulcerate through the iliac fascia and open into the peritoneal cavity, the ascending or descending colon or other portions of the bowel, the ureter, or the bladder. The pus sometimes passes under the anterior lamella of the lumbar fascia into the sheath of the quadratus lumborum muscle, and forms a **lumbar abscess.** This abscess may ulcerate through the middle and posterior lamellæ of the lumbar fascia and into the triangle of Petit, and produce a swelling near the middle of the crest of the ilium. From this description it may be understood how caries of the upper regions of the

CVII.



ordosis. Normal curve. Kyphosis. Lateral curvature.

F



Early Lumbar caries
Normal Curve Effaced

Normal Curve

Advanced dorsi-Lu
Caries Angular C

The *seventh cervical spine* corresponds to the highest level of the apices of the lungs.

The *third thoracic spine* lies opposite the point where the aorta approaches the spinal column, the highest level of the lower lobes of the lungs, and the bifurcation of the trachea.

The *fourth thoracic spine* is located opposite the point of termination of the arch of the aorta and the highest level of the heart.

The *eighth thoracic spine* marks the lowest level of the heart and the level of the central tendon of the diaphragm.

The *ninth thoracic spine* marks the level of the cardiac orifice of the stomach and the upper limit of the spleen.

The *tenth thoracic spine* locates the lowest level of the bases of the lungs and the level at which the liver reaches the abdominal walls posteriorly.

The *eleventh thoracic spine* locates the lower limit of the spleen, the position of the supra-renal capsule, and the upper border of the right kidney.

The *twelfth thoracic spine* is on a level with the lowest part of the pleuræ, the aortic opening of the diaphragm, and the pylorus.

The *spine of the first lumbar vertebra* is situated opposite the renal vessels, the pelvis of the ureter, and the pancreas.

The *second lumbar spine* lies opposite the end of the spinal cord, the third portion of the duodenum, and the receptaculum chyli.

The *third lumbar spine* is found just above the level of the umbilicus and below that of the lower border of the right kidney.

The *fourth lumbar spine* is located opposite the bifurcation of the aorta and the highest part of the crests of the ilia.

The *fifth lumbar spine* marks the origin of the inferior vena cava.

The *third sacral spine* lies opposite the termination of the sigmoid flexure and the lowest level of the spinal membranes.

The *tip of the coccyx* marks the junction of the first and second portions of the rectum.

The **origins of the spinal nerves** will not be found opposite their correspondingly numbered vertebræ, but as follows: The *eight cervical nerves* arise above the sixth cervical spine, the *upper six thoracic nerves* between the sixth cervical and fourth thoracic spines, the *lower six thoracic nerves* between the fourth and eleventh thoracic spines, the *five lumbar nerves* between the eleventh and twelfth thoracic spines, and the *five sacral nerves* between the last thoracic and first lumbar spines.

The **positions of the primary bronchi** are indicated by lines extending from the third thoracic spine, or a point a little below it, to the dimple in the skin

over the root of the spine of the scapula. Sounds are heard more clearly in the right bronchus because it lies nearer the back of the chest.

The **kidneys** are situated opposite the lower two ribs, with their inferior ends projecting below the twelfth rib; to ascertain if any tenderness exist in the diseased organ, pressure may be made upon it just under the last rib, external to the erector spinæ muscle. This, too, is the site selected when operating for removal of, and in exploratory operations upon, the kidney through the back. The right kidney is lower than the left, more than half of it projecting below the last rib.

The **iliac crest** at its highest point is located about opposite the fourth lumbar spine.

The external surface of the **spleen** is directed outward and backward. This organ lies beneath the ninth, tenth, and eleventh ribs, from which it is separated by the peritoneum, diaphragm, the lower portion of the left lung, and the two layers of the left pleura. It holds an oblique position; its long axis almost corresponding to the line of the tenth rib.

To either side of the spinal furrow in the upper part of the back are the **scapulæ,** or shoulder blades, covered by the trapezius, deltoid, supra-spinatus, infra-spinatus, and latissimus dorsi muscles. The scapulæ cover the ribs from the second to the seventh inclusive. The parts of the scapula most readily felt are the spine and the acromion process, both of which are subcutaneous. The position of the acromion is marked by a depression when the arm is elevated, and in muscular subjects with the arm hanging loosely.

At the junction of the outer border of the acromion with the lower border of the spine is found the **acromial angle,** from which point measurements are taken to determine the comparative lengths of the upper extremities. At the inner end of the spine of the scapula is a depression which corresponds to the triangular tendon into which the lower fibers of the trapezius muscle are inserted.

The sloping superior surface of the **shoulder** is formed by the trapezius which

PLATE

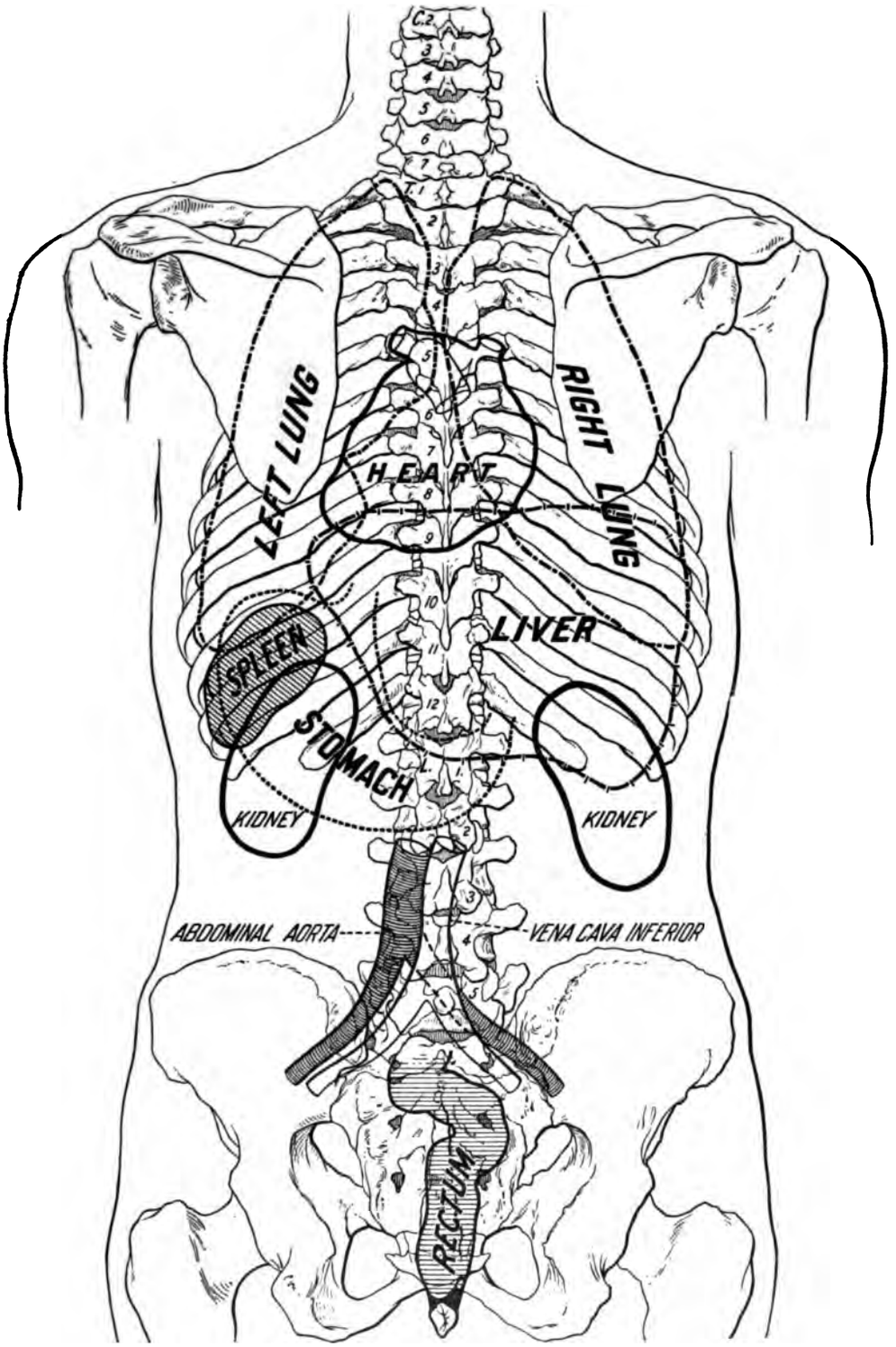
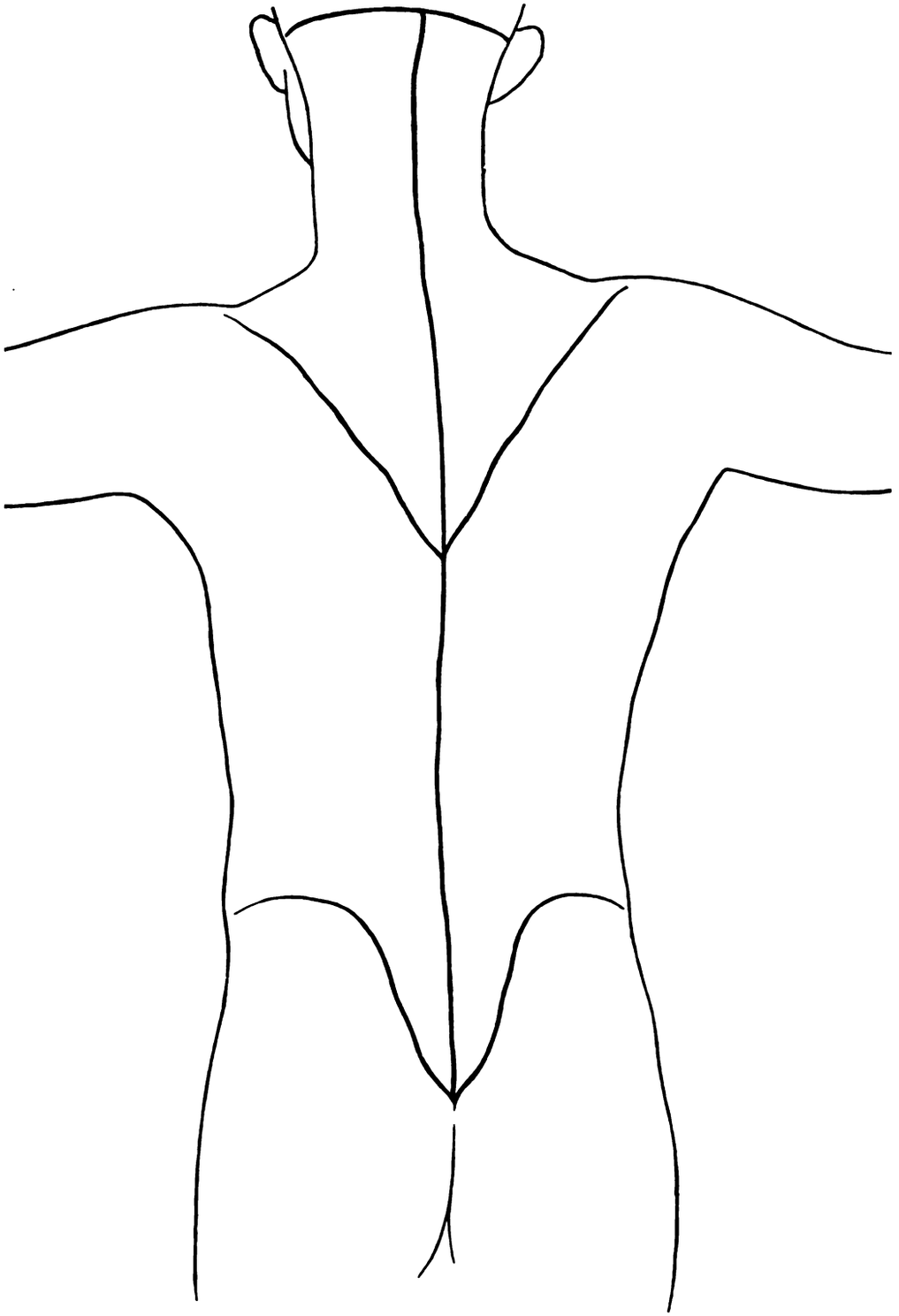

LEFT LUNG
RIGHT LUNG
HEART
LIVER
SPLEEN
STOMACH
KIDNEY
KIDNEY
ABDOMINAL AORTA
VENA CAVA INFERIOR
RECTUM

PLATE I



from the inferior angle, and with the arm hanging by the side of the body is nearly parallel to the spinal furrow. At the upper extremity of this border the *superior angle* of the scapula can be distinguished. With the arm at the side of the body the superior angle of the scapula is opposite the upper border of the second rib and on a level with the interval between the spines of the first and second thoracic vertebræ. The *superior border* of the scapula can but seldom be felt, on account of the thickness of the overlying muscle. The *axillary border* of the scapula can be indistinctly felt through its thick muscular covering.

The *movements* of the scapula are those of gliding upward and downward, as in shrugging the shoulders; backward and forward, as in moving the shoulders in those directions; and a gliding rotatory motion, as when the arm is fully abducted. These movements are best studied in the living subject. On account of the great mobility of the scapula ankylosis of the shoulder-joint does not occasion so much disability as might be expected. In physical examination of the chest posteriorly the patient should fold the arms across the chest, in order to bring the scapulæ forward and uncover as much of the chest wall as possible.

The ribs should always be counted from above downward, as the twelfth rib may not project beyond the outer margin of the erector spinæ muscle and therefore will not be felt distinctly.

DISSECTION.—Place the body, face downward, upon the table, with a block under the chest and one under the pelvis so as to curve the back and permit the head to hang low enough to make the structures of the back tense. The arms should be allowed to hang over the sides of the table to make the structures between the shoulders tense. Carry an incision from the external occipital protuberance down the median line of the back to the sacrum. From the upper end of this incision make another outward over the superior curved line of the occipital bone. Make a third incision from the acromion over the spine of the scapula to the first incision; and, lastly, one from the lower end of the longitudinal cut along the sacro-iliac junction and over the crest of the ilium. Reflect the segments

intercostal and lumbar arteries. Branches of the posterior primary divisions of the spinal nerves furnish the nerve supply.

The **posterior primary branches of the spinal nerves,** with the exception of the first cervical nerve (suboccipital), the fourth and fifth sacral, and the coccygeal nerves, divide into external and internal branches; each primary branch supplies sensory fibers to the skin in each region of the back. Both the external and internal branches supply nerves to the muscles of the back.

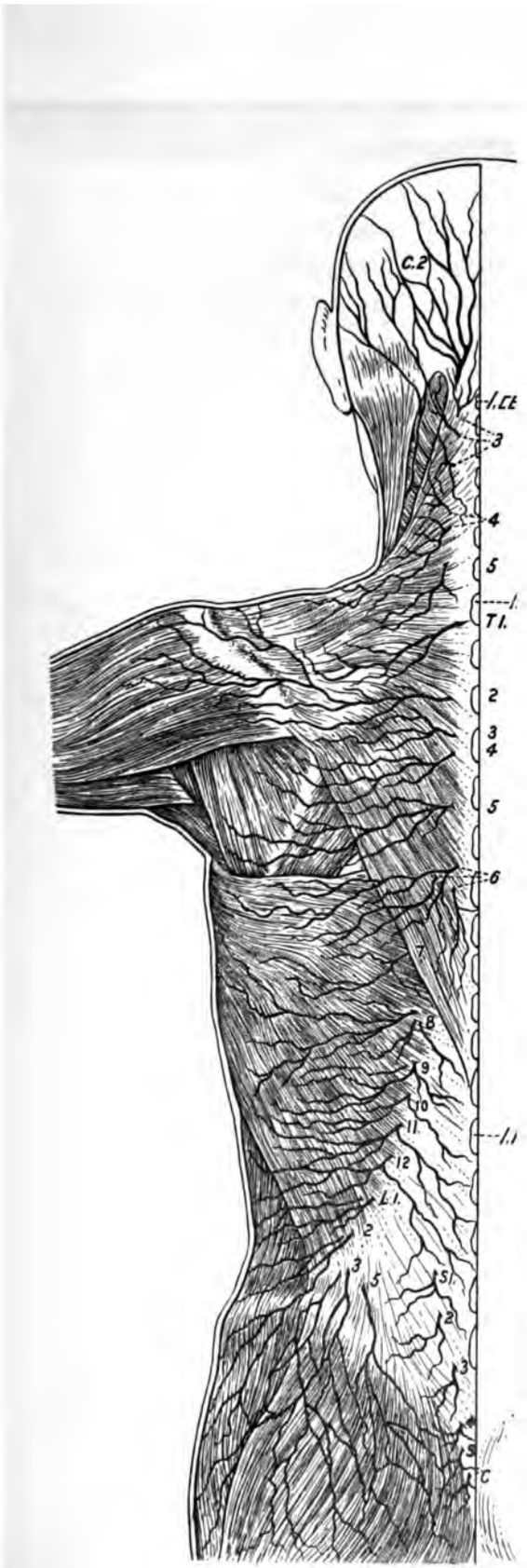
The external branches in the *cervical region* supply the muscles, while the internal branches of the second, third, fourth, and fifth nerves supply the skin, fasciæ, and muscles. The internal branch of the posterior division of the second cervical nerve, the **great occipital,** pierces the complexus and trapezius muscles and ramifies, with the occipital artery, in the superficial fascia of the back of the scalp. The internal branches of the third, fourth, and fifth cervical nerves, after supplying the adjacent muscles, pierce the trapezius muscle near the ligamentum nuchæ and pass outward to supply the skin and fasciæ over that muscle. The internal branch of the third cervical nerve is directed toward the scalp, and is called the **smallest or third occipital nerve.** The branches of the sixth, seventh, and eighth cervical nerves supply the adjacent muscles.

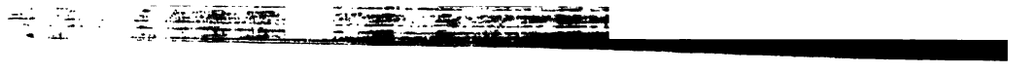
In the *thoracic region* the external branches of the posterior divisions of the upper six thoracic nerves supply the muscles, while the same branches of the lower six, after supplying the muscles, pierce the latissimus dorsi near the angles of the ribs to furnish nerves to the skin. The internal branches of the posterior divisions of the upper six thoracic nerves supply the muscles of the back, and pierce the trapezius near the spinous processes to supply the skin. The internal branches of the lower six thoracic nerves supply the muscles, and send small twigs to the skin.

The external branches of the posterior divisions of the first three *lumbar nerves* supply the adjacent muscles, become subcutaneous at the outer border of the erector spinæ, and pass over the crest of the ilium to supply the skin of the gluteal region; the corresponding branches of the fourth and fifth lumbar nerves supply the erector spinæ muscle. The internal branches of the posterior division of the lumbar nerves are small; they supply the multifidus spinæ muscle.

The posterior primary divisions of the upper four *sacral nerves* emerge at the posterior sacral foramina, while the posterior division of the fifth emerges between the sacrum and coccyx.

The posterior divisions of the upper three *sacral nerves* divide into external and internal branches, while the lower two sacral and the coccygeal nerves do not divide. The external branches of the posterior divisions of the upper three sacral nerves form loops upon the back of the sacrum between themselves and the


C.2
C.3
C.4
C.5
T.1.
T.2
T.3
T.4
T.5
T.6
T.7
T.8
T.9
T.10
T.11
T.12
L.1.
L.2
L.3
L.4
L.5
S.1
S.2
S.3
S.4
S.5
C



external branch of the last lumbar nerve, and upon the posterior surface of the great sacro-sciatic ligament form a second series of loops. From these loops are derived two or three nerves which pierce the gluteus maximus to supply the integument. The internal branches of the posterior divisions of the upper three sacral nerves supply the multifidus spinæ muscle. The posterior divisions of the lower two sacral nerves form loops with the coccygeal nerve and the posterior branch of the third sacral. Branches from these loops supply the skin over the coccyx.

Cutaneous nerves.—The skin of the back is supplied, in the *cervical region*, by the internal branches of the posterior divisions of the second, third, fourth, and fifth cervical nerves; in the *thoracic region* by the internal branches of the posterior divisions of the upper six thoracic nerves, and the internal and external branches of the posterior divisions of the lower six thoracic nerves; in the *lumbar region*, by the external branches of the posterior divisions of the upper three lumbar nerves; over the *sacrum* and *coccyx*, by the external branches of the posterior divisions of the last lumbar nerve, upper three sacral nerves, the posterior divisions of the lower two sacral nerves, and by the coccygeal nerve.

The cutaneous nerves are accompanied by the cutaneous branches of the dorsal branches of the intercostal and lumbar arteries.

Dissection.—The superficial fascia is to be reflected after making incisions similar to those made in the removal of the skin.

The **deep fascia,** dense and fibrous, invests the superficial muscles of the back (trapezius and latissimus dorsi). It is continuous with all the adjacent deep fasciæ, and is attached to the following bony prominences of the back: The spines of the vertebræ with the intervening supra-spinous ligaments, the sacrum, the iliac crests, spines of the scapulæ, and the superior curved ridges of the occipital bone. In the lumbar region the deep fascia blends with the glistening triangular aponeurosis of the latissimus dorsi muscle, which aponeurosis extends from the

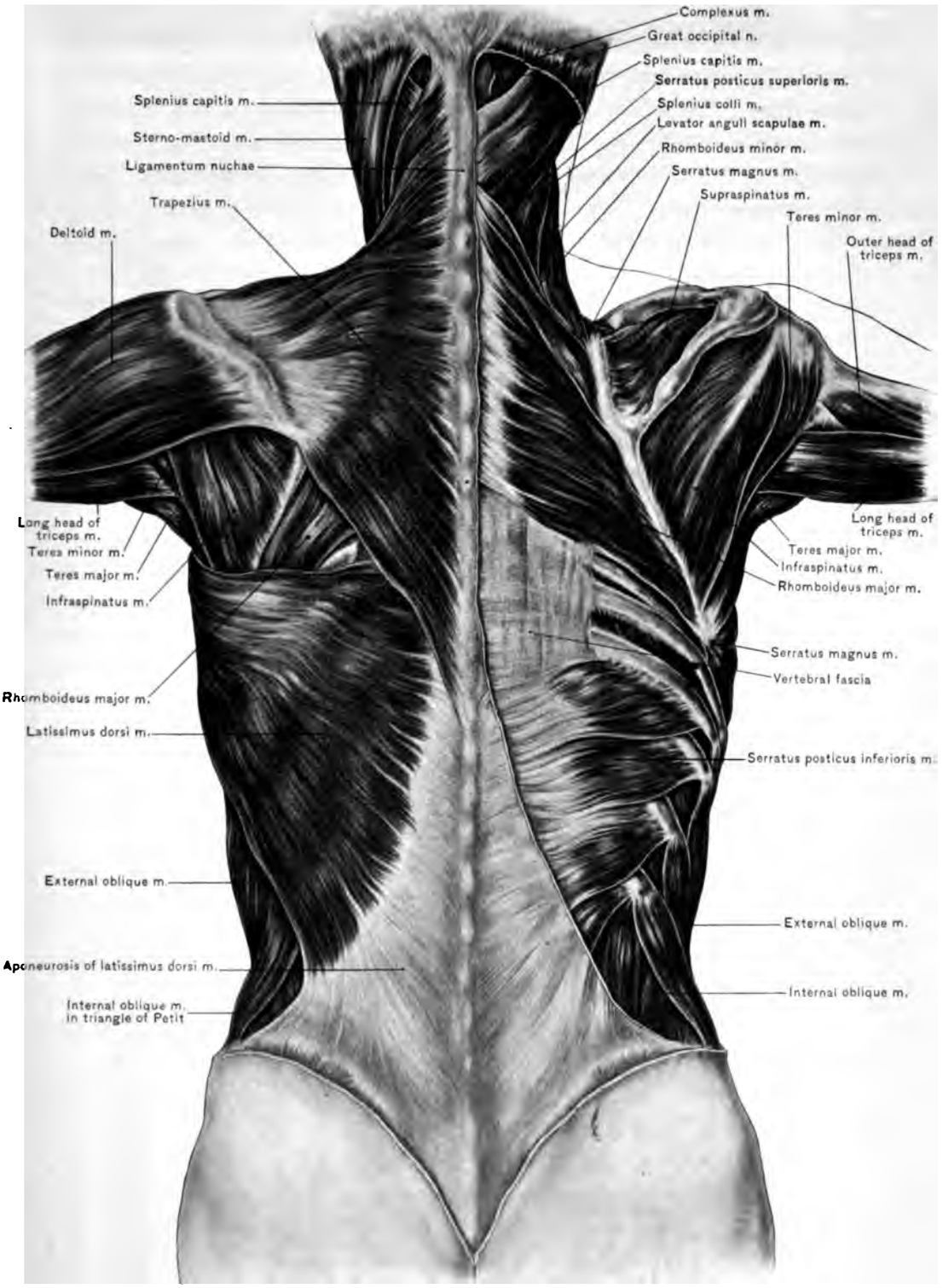
level of the shoulders, the lower part of the trapezius muscle, the latissimus dorsi and its aponeurosis, and the posterior fibers of the external and internal oblique muscles.

The **trapezius** is a broad, flat muscle, triangular in outline, with the base of the triangle directed toward the spines of the vertebræ and the apex toward the summit of the shoulder. It is one of the most extensive muscles of the body. It arises from the inner one-third of the superior curved line of the occipital bone, the external occipital protuberance, the ligamentum nuchæ, the spinous process of the seventh cervical vertebra (vertebra prominens), the spinous processes of all the thoracic or dorsal vertebræ, and from the intervening supra-spinous ligaments. From this extensive origin its fibers converge outward to the top of the shoulder. It is inserted into the contiguous margins of the clavicle, acromion process, and spine of the scapula, being attached to the outer one-third of the posterior border and upper surface of the clavicle, to the inner border of the upper surface of the acromion process, and to the entire length of the upper margin of the spine of the scapula. The lowermost fibers form a triangular aponeurosis at the base of the spine of the scapula, over which it glides to be inserted into a tubercle at the inner extremity of the spine. Between the base of the spine of the scapula and the tendon is a small synovial bursa, which facilitates the movements of the tendon. The muscle is tendinous at its attachments, and is lusterless and adherent to the skin in the occipital region, while between the sixth cervical and third thoracic spines the aponeurosis of origin is semi-elliptic, forming a complete ellipse with its fellow of the opposite side. The two trapezii form a diamond-shaped quadrangle,—a trapezium (hence the name),—with the lateral angles at the shoulders and the vertical angles at the occiput and twelfth dorsal spine.

The trapezius muscle is subcutaneous throughout its entire extent; in the neck it rests upon the complexus, splenius capitis et colli, levator anguli scapulæ, and rhomboideus minor muscles; and in the back upon the rhomboideus major, supra-spinatus, infra-spinatus, part of the serratus posticus superior, latissimus dorsi muscles, and the vertebral aponeurosis. Its anterior cervical border forms the posterior boundary of the posterior common triangle of the neck, and is nearly parallel with the posterior fibers of the sterno-cleido-mastoid muscle.

Blood Supply.—From the princeps cervicis, superficial cervical, and posterior

PLATE CII


Complexus m.
Great occipital n.
Splenius capitis m.
Serratus posticus superioris m.
Splenius colli m.
Levator anguli scapulae m.
Rhomboideus minor m.
Serratus magnus m.
Supraspinatus m.
Teres minor m.
Outer head of triceps m.
Splenius capitis m.
Sterno-mastoid m.
Ligamentum nuchae
Trapezius m.
Deltoid m.
Long head of triceps m.
Teres minor m.
Teres major m.
Infraspinatus m.
Rhomboideus major m.
Latissimus dorsi m.
External oblique m.
Aponeurosis of latissimus dorsi m.
Internal oblique m. in triangle of Petit
Long head of triceps m.
Teres major m.
Infraspinatus m.
Rhomboideus major m.
Serratus magnus m.
Vertebral fascia
Serratus posticus inferioris m.
External oblique m.
Internal oblique m.

same side, and extend the neck. The middle fibers draw the scapula toward the spines of the vertebræ, and rotate it so as to raise the point of the shoulder. The lower fibers draw the shoulder blade inward and downward, and rotate it so as to elevate the point of the shoulder. Acting as a whole, the two muscles draw the scapulæ nearer together; elevate the point of the shoulder, and extend the neck, as in opisthotonos.

The **ligamentum nuchæ** is a fibro-elastic band extending from the external occipital protuberance to the spine of the seventh cervical vertebra, where it is continuous with the supra-spinous ligaments of the back. Fibrous extensions from it to the underlying spines of the cervical vertebræ form a septum between the muscles of the two sides of the back of the neck. It is almost rudimentary in man, but in the living body can be identified through the skin by dropping the head forward and allowing it to hang by its own weight, when the ligament can be demonstrated. In the lower animals, such as the horse, the ligamentum nuchæ holds the head up without any effort; in fact, muscular force is required to carry the head to the ground and hold it there, as in grazing.

The **latissimus dorsi** is a broad, flat, triangular muscle, with an elongated and twisted apex. It lies upon the lower portion of the back and outer side of the chest, covering a part of the side of the latter structure and all of the back from the level of the sixth thoracic vertebra to the crest of the ilium.

This muscle arises by an aponeurosis from the spinous processes of the lower six thoracic, the lumbar, and the sacral vertebræ, the intervening supra-spinous ligaments, the back of the sacrum, and the posterior one-third of the outer lip of the crest of the ilium, and from the lower three or four ribs by fleshy finger-like bands which interdigitate with similar processes of the external oblique muscle. Its sacral origin is in common with that of the erector spinæ muscle, and its aponeurosis is the posterior layer of the lumbar fascia. Its fibers converge to the common tendon. The upper fibers pass horizontally outward over the inferior angle of the scapula; the middle, obliquely upward and outward; and the lower, almost vertically upward. At the side of the chest they form a long, thick, fleshy mass, which sometimes receives an additional slip from the inferior angle of the scapula and passes along the axillary border of that bone in contact with the teres major muscle, around which the latissimus dorsi turns. It is inserted into the bottom of the bicipital groove between the insertions of the teres major and pectoralis major muscles by a flat tendon about three inches long. Near its insertion it twists upon itself so that the lower fibers are inserted highest, and the upper ones lowest. The inferior margin of the tendon is united to that of the teres major muscle, a bursa usually existing between the two. Sometimes there is

turns around the teres major it forms with that muscle the posterior fold of the axilla.

The latissimus dorsi muscle is subcutaneous throughout its entire extent, except at that portion of its origin where it is overlapped by the trapezius muscle. It lies, from below upward, upon the vertebral aponeurosis which covers the erector spinæ muscle and its upward continuations, the serratus posticus inferior muscle, lower ribs, external intercostal muscles, serratus magnus muscle, inferior angle of the scapula, rhomboideus major, infra-spinatus, and teres major muscles. Just above the crest of the ilium there appears, except in very muscular subjects, a triangular interval (*triangle of Petit*), which is bounded below by the crest of the ilium, behind by the anterior border of the latissimus dorsi muscle, and in front by the posterior border of the external oblique muscle. Its floor is formed by the internal oblique muscle. This triangle is not present in very muscular subjects, because the posterior border of the external oblique muscle is overlapped by the latissimus dorsi muscle. When the arm is abducted, a small triangular interval exists between the upper border of the latissimus dorsi muscle, the vertebral border of the scapula, and the trapezius muscle. In the floor of this triangle are found the lower part of the rhomboideus major muscle and the sixth intercostal space. With the exception of the median line of the sternum, this is the only part of the wall of the thorax which is not covered by muscle.

Blood Supply.—From the subscapular artery.

Nerve Supply.—From the long subscapular nerve.

Action.—It is an internal rotator of the humerus and draws the arm downward and backward. Acting from its insertion it elevates the lower ribs, as in forced inspiration, laterally flexes the spinal column, and draws the trunk and pelvis forward and upward, and hence is much used in horizontal-bar exercise and climbing. It is well developed in swimmers, as it draws the arm downward and at the same time rotates it inward.

Dissection.—The trapezius muscle should now be cut through about one and one-half inches from its vertebral attachment and reflected outward, carrying with it the deep layer of the deep fascia which covers the under surface of the muscle. Dissection of the deep surface of the trapezius muscle will demonstrate the presence of the spinal accessory nerve, branches of the cervical plexus, and the terminal portion of the superficial cervical artery. The nerve filaments join to form the subtrapezial plexus, twigs from which supply the muscle. In close relation with the lower portion of the spinal accessory nerve is the superficial cervical artery, which, if traced downward to the anterior border of the trapezius muscle, will be

attached to the posterior, or vertebral, border of the scapula: The levator anguli scapulæ, above the base of the spine; the rhomboideus minor, opposite the base of the spine; and the rhomboideus major, below the base of the spine. The posterior belly of the omo-hyoid muscle, which arises from the upper border of the scapula internal to the supra-scapular notch, will also be seen.

The **levator anguli scapulæ muscle** arises from the posterior tubercles of the transverse processes of the upper four cervical vertebræ by four tendinous slips. These slips unite to form a flat, fleshy mass, which passes down the back of the side of the neck to be inserted into the vertebral border of the scapula above the base of the spine. Its superficial surface is in relation with the deep fascia of the neck, the middle scalene, the trapezius, and sterno-mastoid muscles, the internal jugular vein, the spinal accessory nerve, and some of the descending branches of the cervical plexus. It rests upon the splenius colli, transversalis colli, cervicalis ascendens, and serratus posticus superioris muscles, and the posterior scapular vessels.

Blood Supply.—From the vertebral, ascending cervical, superficial cervical, and posterior scapular arteries.

Nerve Supply.—From the fifth cervical nerve, and additional filaments from the deep branches of the cervical plexus.

Action.—This muscle draws the upper angle of the scapula upward and forward, at the same time rotating that bone so as to depress the summit of the shoulder. Acting from its insertion, it inclines the neck to one side and extends it.

The **rhomboideus minor** is a small, flat, ribbon-like muscle arising from the lower end of the ligamentum nuchæ, the last cervical and first thoracic spines, and the supra-spinous ligament. It extends obliquely downward and outward, and is inserted into the vertebral border of the scapula opposite the base of the spine. It is covered by the trapezius muscle, and lies upon the serratus posticus superioris and intercostal muscles, the posterior scapular artery, and the ribs.

Blood Supply.—From the posterior scapular artery.

Nerve Supply.—From a branch of the fifth cervical nerve which will be seen beneath the rhomboidei.

Action.—It draws the scapula upward and inward toward the spinal column.

The **rhomboideus major muscle** lies below the rhomboideus minor, and is about three times as broad. It arises from the upper four or five thoracic spines and their supra-spinous ligaments, and is inserted into the vertebral border of the scapula opposite the infra-spinous fossa.

This muscle and the rhomboideus minor have similar relations, except that

BLOOD SUPPLY.—From the posterior scapular artery.

NERVE SUPPLY.—From a branch of the fifth cervical nerve.

ACTION.—It draws the scapula upward and inward toward the spinal column, and rotates the scapula so as to depress the summit of the shoulder.

DISSECTION.—The fatty tissue covering the posterior belly of the **omo-hyoid muscle** should be removed, when this muscle will be seen to arise from the superior border of the scapula immediately internal to the supra-scapular notch, and in part from the ligament converting the notch into a foramen. It passes forward and upward into the neck.

Divide the posterior belly of the omo-hyoid muscle a short distance above its origin and reflect it upward. This will expose the supra-scapular artery and nerve on their way to enter the supra-scapular fossa.

Before dividing the levator anguli scapulæ and rhomboidei muscles the dissector should turn his attention to the cap of the shoulder, as this covers many of the structures to be considered.

The **cap of the shoulder** is formed by the deltoid muscle, which is covered by a part of the deep fascia called the deltoid aponeurosis. This aponeurosis is thick and strong, and sends many septa between the bundles of fibers of the muscle. The fascia is continuous with that covering the pectoralis major muscle in front and the infra-spinatus muscle behind, and is attached to the clavicle, acromion, and spine of the scapula.

The **deltoid muscle** resembles an inverted triangle with an indented base; or the Greek ⅃ inverted; hence its name, delta-like. It arises from the shoulder girdle opposite the insertion of the trapezius muscle, and so marked is this that the clavicle and acromion process and spine of the scapula seem but bony interruptions in one grand trapezo-deltoid muscle which is inserted into the middle of the humerus. It arises from the outer one-third of the anterior border of the clavicle, the outer border and superior surface of the acromion process, and the entire lower border of the spine of the scapula. From these points its fibers converge to form a thick, short tendon, which is inserted into the middle of

a large sacculated bursa. It covers the coracoid process of the scapula, the tendons of the pectorales major and minor, the coraco-brachialis, the subscapularis, the short and long heads of the biceps, the supra-spinatus, the infra-spinatus, the teres minor, the long and outer heads of the triceps, the coraco-clavicular and coraco-acromial ligaments, the circumflex vessels and nerve, and the upper end of the humerus. Anteriorly, it adjoins the upper, outer margin of the pectoralis major muscle, with which it forms the delto-pectoral sulcus in which is lodged the cephalic vein and the descending branch of the acromio-thoracic artery. Abscess of the shoulder-joint, or the subdeltoid bursa, rarely burrows through the substance of this muscle but usually points at one of its borders.

Atrophy of the deltoid muscle causes the acromion process to appear more prominent, and a depression to exist beneath it. This condition is caused by disuse, as in ankylosis of the shoulder-joint; more frequently by diseases of the spinal cord, as acute anterior polio-myelitis; by ascending neuritis of the circumflex nerve, usually due to disease of the shoulder-joint and causing paralysis of the muscles; and by injury of the circumflex nerve, by a blow or fracture of the upper part of the humerus. A careless observer might regard a case of atrophy of the deltoid one of dislocation of the head of the humerus.

Blood Supply.—From the acromio-thoracic, the anterior and posterior circumflex arteries.

Nerve Supply.—From the circumflex nerve.

Action.—It is by no means simple in its action. The whole muscle abducts the arm, raising it to a right angle with the body. The posterior fibers retroduct the arm and rotate it outward; and the anterior fibers draw the arm forward and rotate it inward. Thus this muscle draws the arm forward, backward, or outward, and rotates it inward or outward.

Dissection.—Divide the deltoid muscle about one inch from its origin, and reflect it downward. This will expose the structures already enumerated as in relation with its under surface. When reflecting the muscle, the bursa separating the deltoid muscle from the acromion process and the greater tuberosity may have been opened; but if it be still intact, it should be incised and its extent carefully noted by passing the finger into it. In some injuries of the shoulder this bursa may be affected by traumatic bursitis, with marked increase of the fluid contents of the sac. This would cause much prominence of the shoulder cap, and the consequent increased pressure would account for much of the pain experienced upon movement of the arm.

Divide the latissimus dorsi muscle just above the level of the inferior angle

Circumflex arteries and nerve.—The anterior and posterior circumflex arteries and the circumflex nerve, which have been described with the dissection of the axilla, will be seen on the under surface of the reflected deltoid muscle.

The **teres major muscle** arises from the lower part of the axillary border of the scapula, from the back of the inferior angle of the scapula, and from the fibrous septum between the teres major and the teres minor muscle. It passes upward and outward, and forms a short, flat tendon, which is inserted into the posterior bicipital ridge of the humerus behind the tendon of the latissimus dorsi muscle, from which it is separated by a bursa.

BLOOD SUPPLY.—From the subscapular and posterior circumflex arteries.

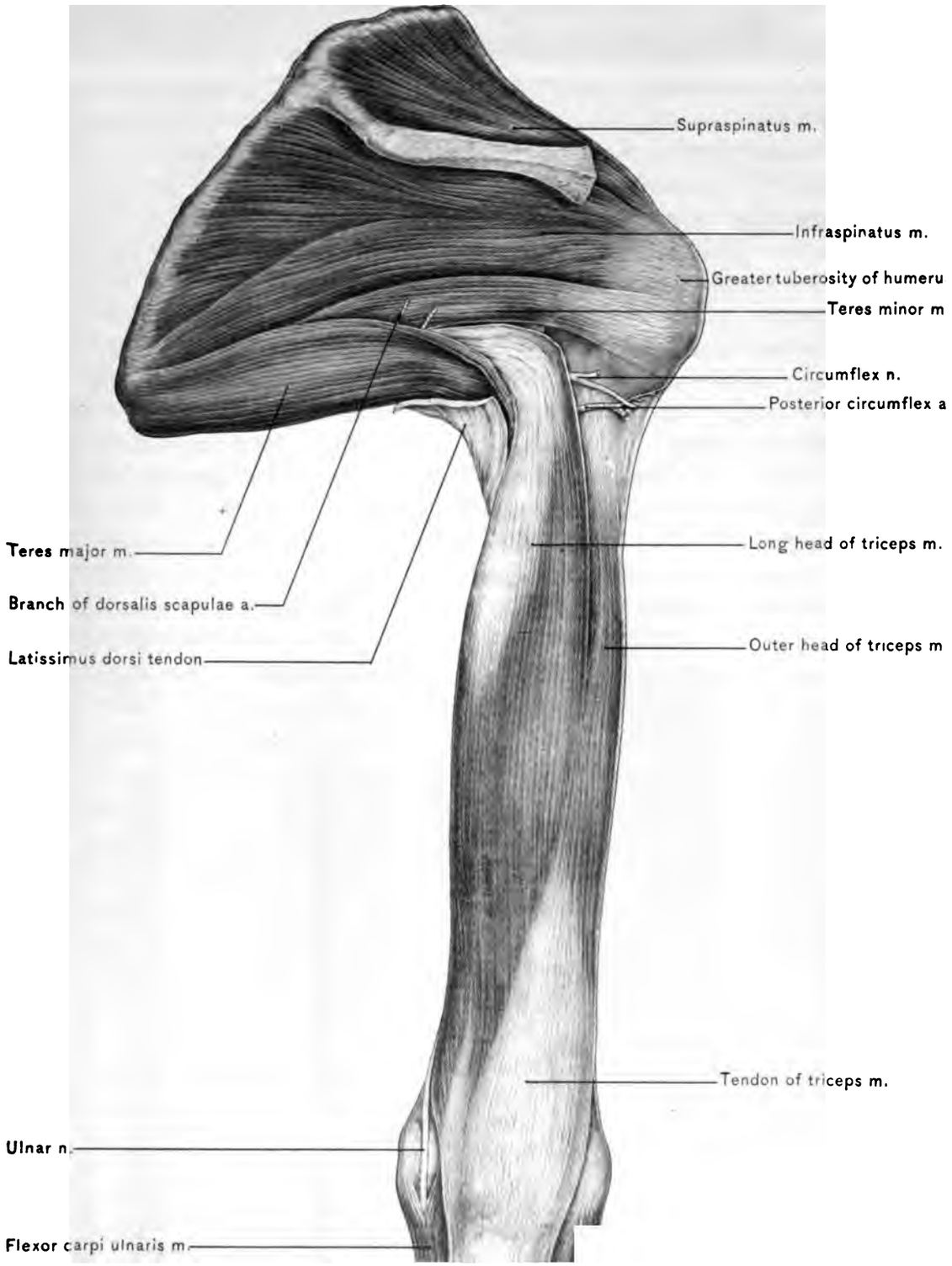
NERVE SUPPLY.—From the lower subscapular nerve.

ACTION.—It assists the latissimus dorsi muscle in adducting the arm and rotating it inward; if the arm be fixed upward and forward, it rotates the scapula by drawing the lower angle forward; and if the scapula also be fixed, it assists the latissimus dorsi muscle in drawing the trunk upward and forward, as in climbing.

The **infra-spinous fascia** is a dense membrane which covers the infra-spinatus and teres minor muscles. It is attached to the circumference of the infra-spinous fossa, and gives origin to some of the fibers of the muscles which it covers. At the outer border of the deltoid it gives off a process which passes over that muscle. This fascia must be removed to expose the underlying muscles.

The **teres minor muscle** hugs the axillary border of the scapula. It arises from the upper two-thirds of the dorsal surface of this margin. There is an aponeurotic lamina between it and the teres major muscle, and a lamina between it and the infra-spinatus muscle. It passes upward and outward, slightly diverging from the teres major muscle, and is inserted into the lowermost of the three facets upon the greater tuberosity of the humerus and the bone just below it. It is covered by infra-spinous fascia, the deltoid muscle, and the deep fascia, while beneath it are the scapula, the dorsalis scapulæ artery, the long head of the triceps muscle, the teres major and the subscapularis muscle, and the back of the shoulder-joint. Its upper border is in contact with the infra-spinatus muscle, while the lower border assists in forming the upper boundary of the subscapular triangle.

BLOOD SUPPLY.—From the posterior circumflex and dorsalis scapulæ arteries.


Supraspinatus m.
Infraspinatus m.
Greater tuberosity of humeru
Teres minor m
Circumflex n.
Posterior circumflex a
Teres major m.
Long head of triceps m.
Branch of dorsalis scapulae a.
Latissimus dorsi tendon
Outer head of triceps m
Tendon of triceps m.
Ulnar n.
Flexor carpi ulnaris m.

their divergence (the teres minor being behind and the teres major in front), subdividing this interval into an inner triangular and an outer rectangular space. (See Dissection of Axilla.) The former gives passage to the dorsalis scapulæ vessels, and the latter to the posterior circumflex vessels and the circumflex nerve.

The **scapula** has two dorsal fossæ, separated by the spine of the bone, and one anterior, or ventral, making three in all, from each of which arises a muscle; these muscles are known as the supra-spinatus, infra-spinatus, and subscapularis.

The **infra-spinatus muscle,** thick and triangular, arises from the inner two-thirds of the infra-spinous fossa, the under surface of the spine of the scapula, the infra-spinous fascia, and the septum separating it from the teres major and teres minor muscles. Its fibers converge to a tendon which passes below the concave outer border of the spine of the scapula, and crosses the shoulder-joint to be inserted into the middle facet upon the greater tuberosity of the humerus. A bursa, which sometimes communicates with the shoulder-joint, occasionally exists between the tendon and the outer border of the spine of the scapula. This muscle is covered by the *infra-spinous fascia*, which sends fibrous septa between it and the two teres muscles, and is continuous with the deep fascia of the arm. It is also covered by the deltoid, trapezius, and latissimus dorsi muscles. Beneath it lie the scapula, the supra-scapular vessels and nerve, the dorsalis scapulæ vessels, and the capsule of the shoulder-joint. External to it are the teres major and teres minor muscles.

Blood Supply.—From the dorsalis scapulæ and supra-scapular arteries.

Nerve Supply.—From the supra-scapular nerve.

Action.—It rotates the humerus outward, adducts it, and aids in holding the head of that bone in place.

Dissection.—The acromial end of the clavicle and the acromion process should be removed so as to fully expose the top of the shoulder-joint, and afford a clearer view of the muscles inserted into the greater tuberosity of the humerus.

The **supra-spinous fascia** is a dense membrane covering the supra-spinatus muscle, and giving origin to some of its fibers. It is very thick internally but less so under the coraco-acromial ligament. It is attached to the margins of the supra-spinous fossa, and must be removed to expose the supra-spinatus muscle.

The **supra-spinatus muscle** fills the supra-spinous fossa, and arises from its inner two-thirds, the upper surface of the spine of the scapula, and the fascia

shoulder-joint, the supra-scapular vessels and nerve, the omo-hyoid muscle, and the scapula.

BLOOD SUPPLY.—From the supra-scapular artery.

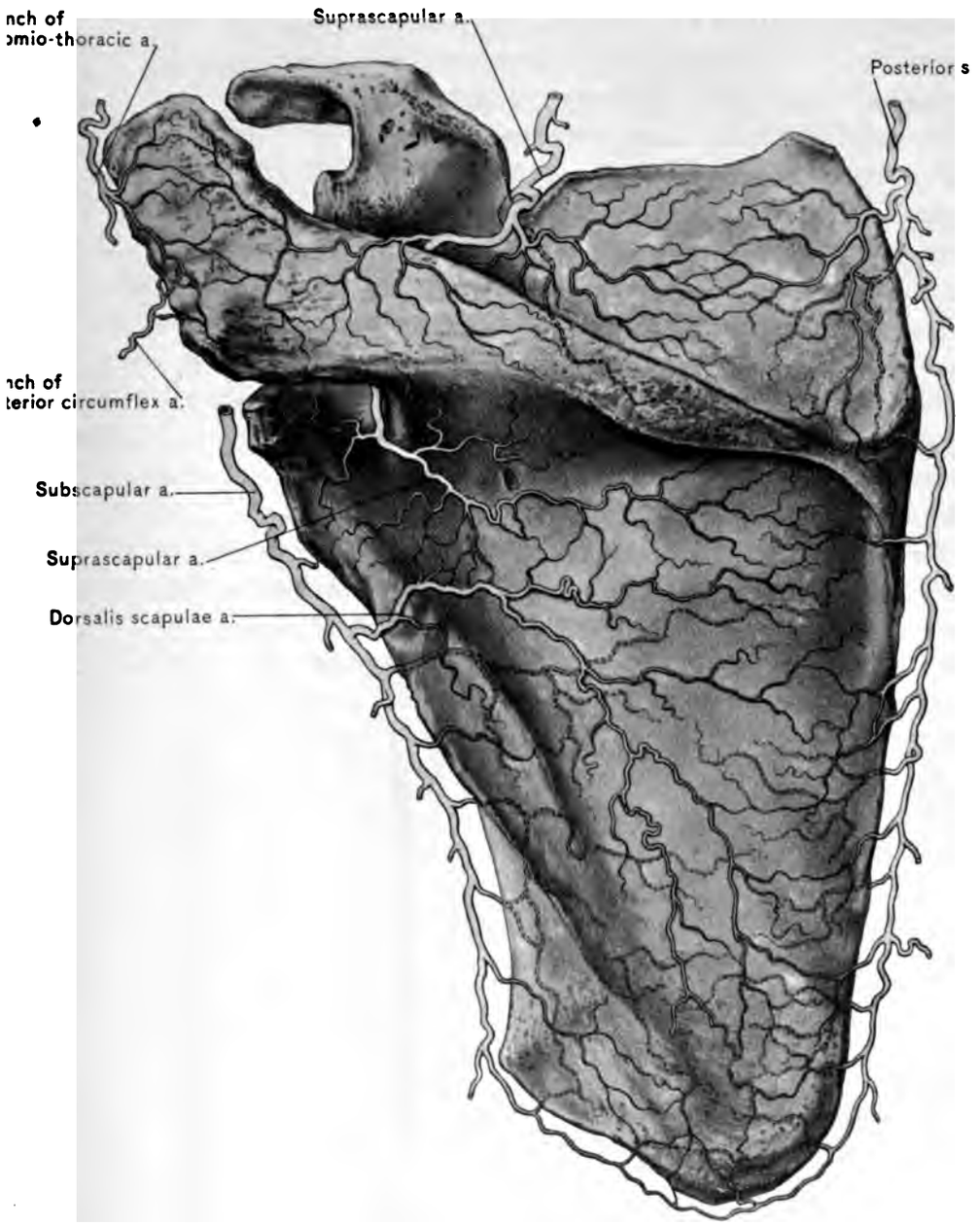
NERVE SUPPLY.—From the supra-scapular nerve.

ACTION.—It assists the deltoid muscle in abducting the arm, and holds the head of the humerus in contact with the glenoid fossa.

DISSECTION.—Having carefully studied the muscles just described, the dissector, in order to obtain a better view of the vessels and nerve which pass beneath them, should divide the levator anguli scapulæ muscle near its attachment to the base of the scapula and reflect it upward; the infra-spinatus and supra-spinatus muscles should be divided near their insertions and reflected inward; divide the rhomboidei muscles near their insertion and reflect them outward; then divide the teres minor muscle near its insertion and reflect it downward.

The **posterior scapular artery,** one of the terminal branches of the transversalis colli, runs beneath the vertebral border of the scapula, between the levator anguli scapulæ and the rhomboidei muscles behind and the serratus magnus muscle in front, to the inferior angle of that bone, where it anastomoses with the terminal portion of the subscapular artery. In its course it gives off numerous branches, which ramify on the dorsal and ventral aspects of the scapula. These branches supply the rhomboidei, supra-spinatus, infra-spinatus, trapezius, and latissimus dorsi muscles. They anastomose with the supra-scapular, dorsalis scapulæ, subscapular, and branches of the intercostal arteries. The posterior scapular often arises from the third portion of the subclavian artery. The nerve to the rhomboidei muscles accompanies this artery.

The **supra-scapular artery,** a branch of the thyroid axis, after passing along the under surface of the posterior belly of the omo-hyoid muscle enters the supra-spinous fossa by passing over the transverse ligament. It traverses that fossa beneath the supra-spinatus muscle and passes around the outer border of the spine of the scapula and enters the infra-spinous fossa. Within these fossæ it supplies the supra-spinatus and infra-spinatus muscles, and anastomoses with the posterior


nch of
ɔmio-thoracic a.
Suprascapular a.
Posterior s
ɪch of
terior circumflex a.
Subscapular a.
Suprascapular a.
Dorsalis scapulae a.

the supra-scapular and posterior scapular arteries. It sends a branch along the axillary border of the scapula, between the teres major and minor muscles, to the posterior surface of the inferior angle of that bone, where it again anastomoses with the posterior scapular artery.

The **subscapularis,** a large and triangular muscle, fills the subscapular fossa. It arises from the inner two-thirds of that fossa, except from the front of the upper and lower angles and the front of the posterior border to which the serratus magnus muscle is attached. Its scapular origin is fleshy, except at the ridges on the bone, where it is tendinous. Its fibers converge to a strong tendon, which lies below the base of the coracoid process, and is inserted into the lesser tuberosity of the humerus; those fibers arising from the axillary border are inserted into the surgical neck of the humerus for an inch below the lesser tuberosity. Between its tendon and the coracoid process is found a large bursa, which communicates with the shoulder-joint. The muscle is covered by a thin *subscapular aponeurosis* attached to the entire circumference of the fossa, and gives origin to some of its fibers. In addition to this covering it lies behind the serratus magnus and coraco-brachialis muscles, the short head of the biceps, the axillary vessels and brachial plexus, and some of their branches. Behind, it rests upon the scapula, the teres minor muscle, the long head of the triceps, the capsule of the shoulder-joint, and the intervening bursa. To its outer side are the teres major and the latissimus dorsi muscle, the posterior circumflex and dorsalis scapulæ vessels, and the circumflex nerve.

Blood Supply.—From the axillary and subscapular arteries.

Nerve Supply.—From the short and lower subscapular nerves.

Action.—It is an internal rotator of the humerus, draws the arm downward after it has been raised, and holds the head of the humerus in place.

Dissection.—The anterior dissection of the chest having been made, the clavicle should be severed, when the serratus magnus muscle will be the only remaining connection between the trunk and upper extremity.

The **serratus magnus muscle** is closely attached to the upper outer anterior part of the thorax. It arises by nine fleshy digitations from the upper eight ribs

superior angle of the scapula. The *middle portion* consists of the third, fourth, fifth digitations arising from the second, third, and fourth ribs and intervening intercostal spaces. It is a thinner and wider layer than the preceding portion, and passes horizontally backward to be inserted into the anterior surface of the vertebral border of the scapula between the upper and lower angles. The *lower portion* consists of the remaining four digitations arising from the fifth, sixth, seventh, and eighth ribs and the corresponding intervals, and interdigitates with the upper serrations of the external oblique muscle. Its fibers pass upward, outward, and backward, to be inserted into the oval space on the anterior surface of the inferior angle of the scapula. The serratus magnus muscle is in relation superficially with the pectoralis major and minor muscles, the subscapularis and latissimus dorsi muscles, the subclavian and axillary vessels, the axillary or brachial plexus of nerves, and the posterior or long thoracic nerve. It covers the ribs, intercostal muscles, and serratus posticus superioris muscle.

Blood Supply.—From the axillary and intercostal arteries.

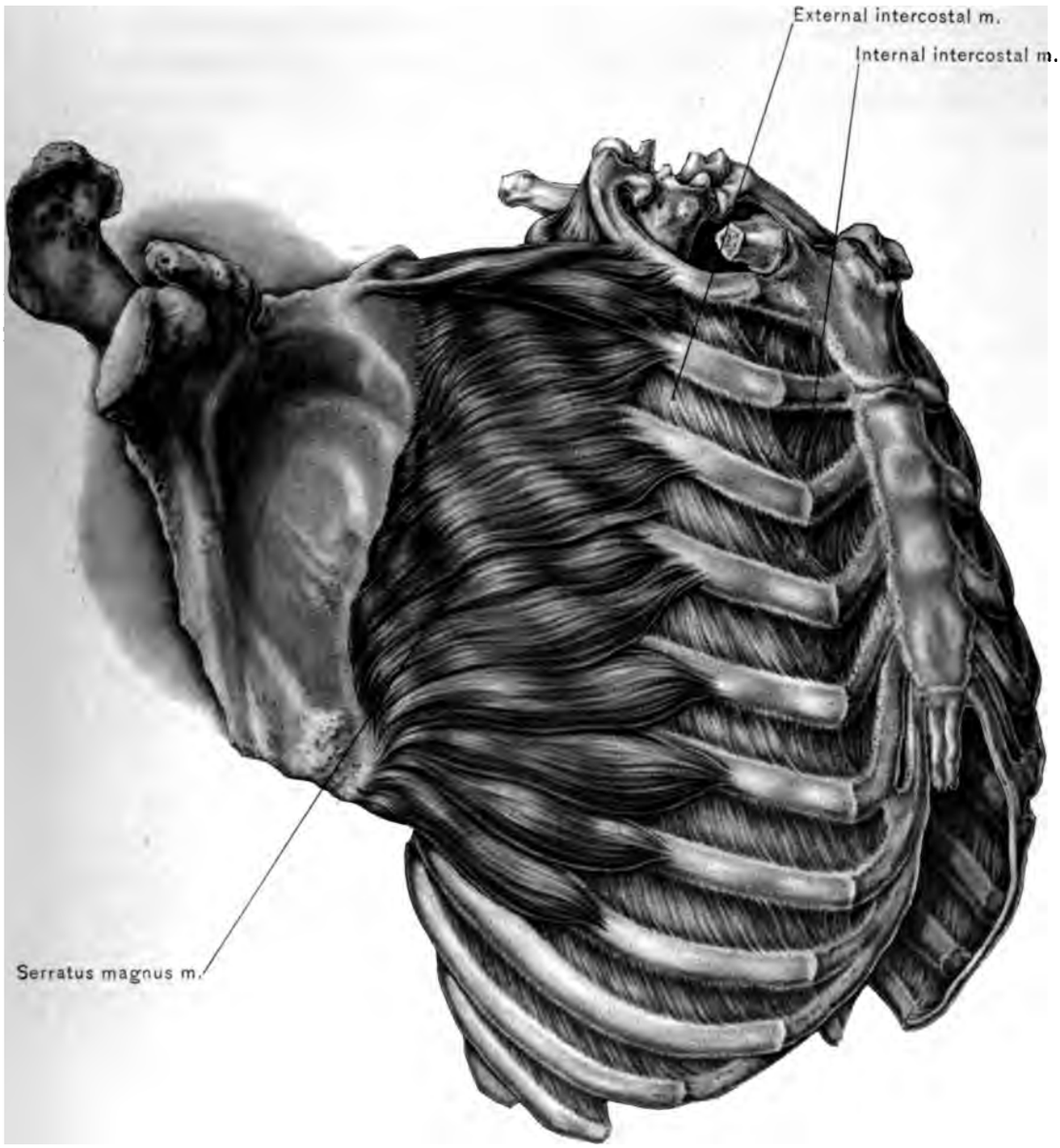
Nerve Supply.—From the posterior or long thoracic nerve (external respiratory of Bell). This nerve is seen running over the muscle at the side of the chest.

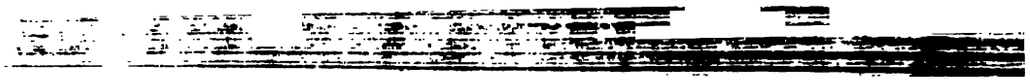
Action.—It draws the scapula and entire shoulder forward, thus increasing the forward reach of the arm and antagonizing the rhomboidei muscles and central fibers of the trapezius muscle. If the scapulæ are fixed close to the spinal column, the lower fibers of the two serratus magnus muscles will evert and draw the ribs upward, thus pushing the sternum outward and increasing the antero-posterior and lateral diameters of the chest. It helps sustain weight upon the shoulder by holding the lower angle of the scapula forward, thus aiding the trapezius in drawing the summit of the shoulder upward. It holds the scapulæ firmly against the chest wall, and its lowest portion—by far the strongest—pulls the inferior angle of the scapula forward. It steadies the scapula while the deltoid muscle abducts the arm to a right angle; then, by rotating the inferior angle forward, it can raise

PLATE CV.

Long head of biceps m.
Subscapularis m.
Teres major m.
Long head of triceps m.
Latissimus dorsi tendon
Outer head of triceps m.
Pectoralis major tendon
Inner head of triceps m.

PLATE CVI.


External intercostal m.
Internal intercostal m.
Serratus magnus m.



entire length of the shoulder girdle—*i. e.*, the clavicle, acromion, and spine of the scapula. It is inserted into the anterior bicipital ridge and the middle of the outer side of the shaft of the humerus.

The following grouping of the seventeen muscles attached to the scapula will be of considerable aid to the student in remembering them:

Three to the vertebral border, . . .	Serratus magnus muscle. Rhomboideus minor muscle. Rhomboideus major muscle.
Three to the axillary border, . . .	Long head of triceps muscle. Teres minor muscle. Teres major muscle.
Three to the three fossæ, ...	Supra-spinatus muscle. Infra-spinatus muscle. Subscapularis muscle.
Three to the coracoid process, . . .	Short head of biceps muscle. Coraco-brachialis muscle. Pectoralis minor muscle.
Three irregularly attached, ...	Omo-hyoid muscle. Long head of the biceps muscle. Levator anguli scapulæ muscle.
Two to the spine of the scapula, . .	Trapezius muscle. Deltoid muscle.

DISSECTION.—It is now necessary to remove the arm and scapula. This can be done by dividing the coraco-clavicular ligament, the serratus magnus muscle at its origin, and the axillary vessels and brachial plexus of nerves.

There are two serratus posticus muscles—the superior and inferior. The superior lies under the three muscles attached to the vertebral border of the scapula; and the inferior under the latissimus dorsi muscle.

The **serratus posticus superioris** is a thin, flat muscle, which arises by a thin aponeurosis from the lower end of the ligamentum nuchæ, the last cervical and the upper two or three thoracic spines; it is inserted by four fleshy slips into the upper borders of the second, third, fourth, and fifth ribs beyond their angles. The fibers are directed downward and outward. It is covered by the trapezius and the levator anguli scapulæ and the rhomboidei muscles. It lies upon the splenius

ACTION.—It draws upward the ribs to which it is attached, assisting in inspiration.

The **serratus posticus inferioris** is also a thin, flat muscle. It arises by an aponeurosis from the last two dorsal and upper two or three lumbar spines and from the interspinous ligaments. It passes upward and outward, and is inserted by four fleshy digitations into the lower borders of the lower four ribs beyond their angles. It is covered by the latissimus dorsi muscle and rests upon the erector spinæ and its continuations, upon the levatores costarum and intercostal muscles, and ribs. Its upper margin blends with the vertebral aponeurosis.

NERVE SUPPLY.—From the branches of the tenth and eleventh intercostal nerves.

ACTION.—It depresses and fixes the lower four ribs, resisting the action of the diaphragm, which tends to elevate and draw forward the lower ribs; it is a muscle of inspiration.

The **splenius muscle** (splenius capitis et colli) arises from the lower two-thirds of the ligamentum nuchæ, and, by tendinous slips, from the spines of the last cervical and upper six thoracic vertebræ, and the intervening interspinous ligaments. It passes upward and outward, expanding into a broad, flat muscle which divides into two portions, one going to the head and the other to the neck. The head segment (splenius capitis) is inserted into the mastoid process of the temporal bone and the surface of the occipital bone below the superior curved line and under the sterno-cleido-mastoid muscle. The neck segment (splenius colli) is inserted into the posterior tubercles of the transverse processes of the upper three or four cervical vertebræ. The muscle is covered by the posterior process of the deep cervical fascia and the following muscles: Trapezius, serratus posticus superioris, rhomboidei, levator anguli scapulæ, sterno-cleido-mastoid. It lies upon the spinalis dorsi, semi-spinalis colli, longissimus dorsi, cervicalis ascendens, transversalis colli, complexus, and trachelo-mastoid muscles.

NERVE SUPPLY.—From the external branches of the posterior divisions of the lower cervical nerves.

ACTION.—It extends the head and neck, rotates them to the same side, and

PLATE CVII.

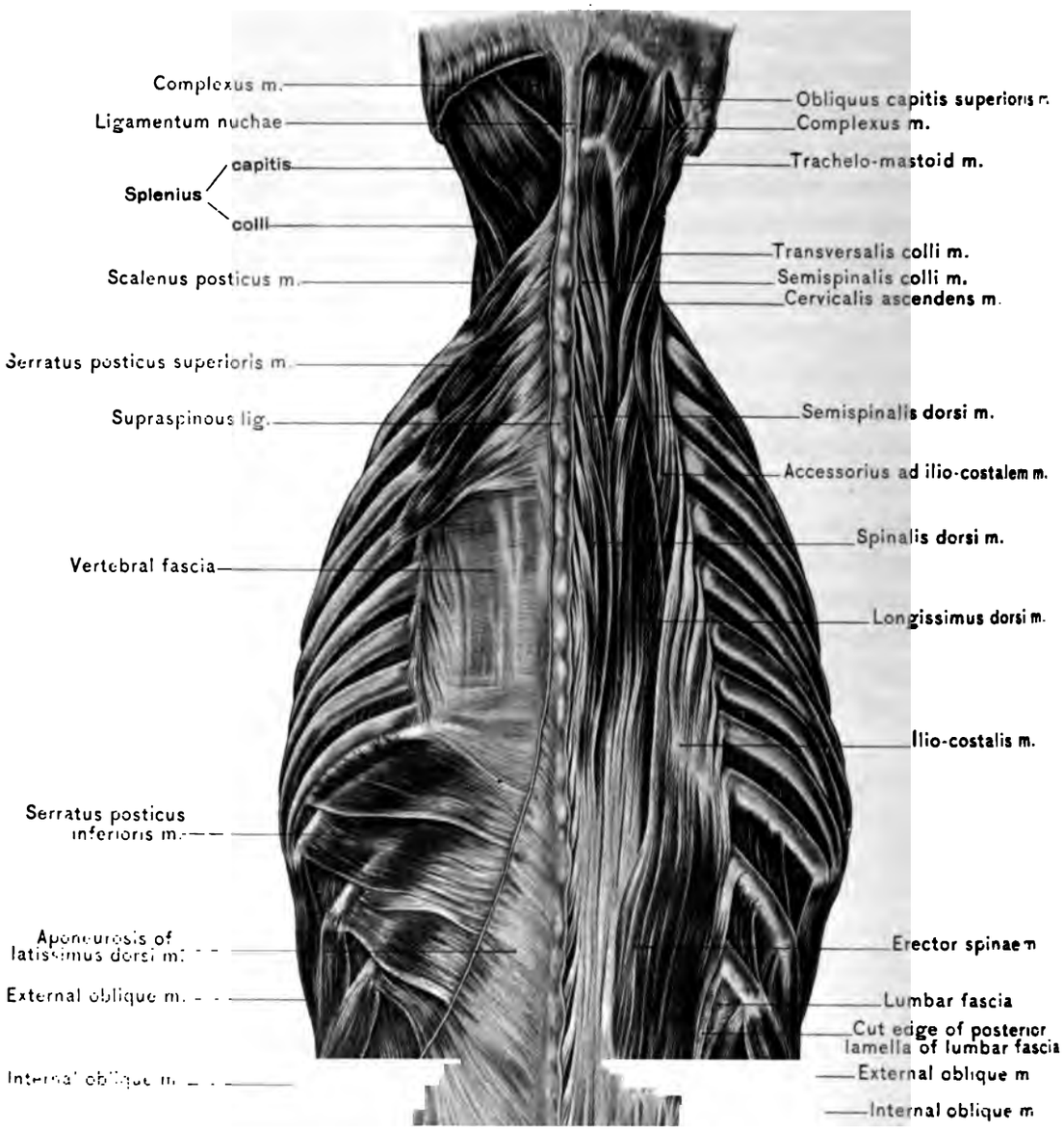
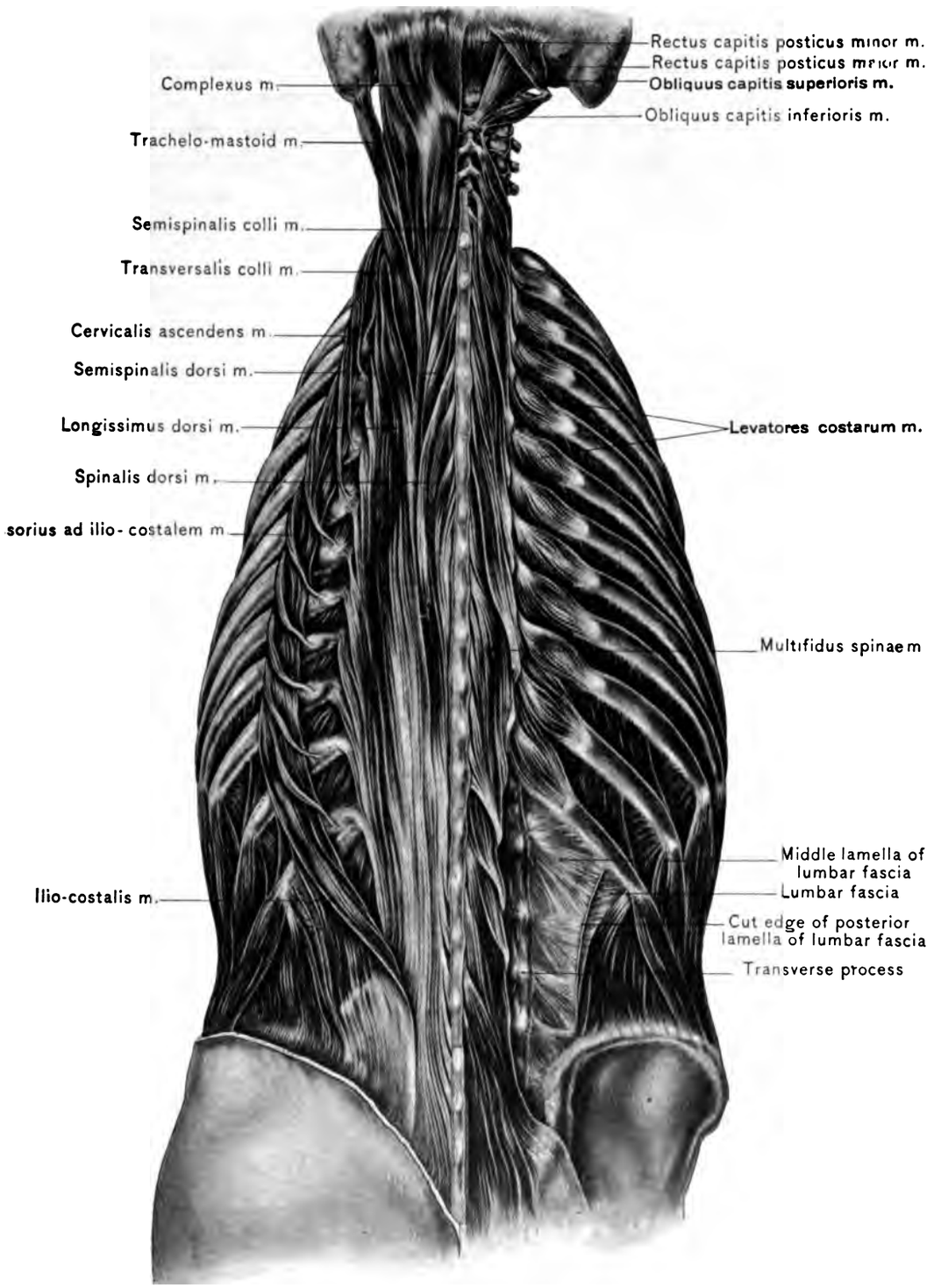

Complexus m.
Ligamentum nuchae
Splenius
capitis
colli
Scalenus posticus m.
Serratus posticus superioris m.
Supraspinous lig.
Vertebral fascia
Serratus posticus inferioris m.
Aponeurosis of latissimus dorsi m.
External oblique m.
Internal oblique m.
Obliquus capitis superioris m.
Complexus m.
Trachelo-mastoid m.
Transversalis colli m.
Semispinalis colli m.
Cervicalis ascendens m.
Semispinalis dorsi m.
Accessorius ad ilio-costalem m.
Spinalis dorsi m.
Longissimus dorsi m.
Ilio-costalis m.
Erector spinae m.
Lumbar fascia
Cut edge of posterior lamella of lumbar fascia
External oblique m.
Internal oblique m.

PLATE CVIII.


Rectus capitis posticus minor m.
Rectus capitis posticus major m.
Obliquus capitis superioris m.
Obliquus capitis inferioris m.
Complexus m.
Trachelo-mastoid m.
Semispinalis colli m.
Transversalis colli m.
Cervicalis ascendens m.
Semispinalis dorsi m.
Longissimus dorsi m.
Spinalis dorsi m.
sorius ad ilio-costalem m.
Levatores costarum m.
Multifidus spinae m.
Middle lamella of lumbar fascia
Lumbar fascia
Cut edge of posterior lamella of lumbar fascia
Transverse process
Ilio-costalis m.

appendicular muscles—*i. e.*, those muscles upon the back which unite the trunk with the upper limb.

DISSECTION.—Beginning from below, remove the aponeurosis of the latissimus dorsi muscle, the serratus posticus inferioris muscle, and the vertebral fascia. Divide the serratus posticus superioris and splenius muscles at their middle, and reflect the two halves. This exposes the erector spinæ muscle and its upward continuations and the greater part of the complexus muscle.

The **erector spinæ** is an extensive, sectional fibro-muscular mass with numerous costo-vertebral attachments extending the entire length of the spine. It is densely fibrous and pointed in the sacral region, becomes very muscular in the lumbar region, and divides in the lower dorsal region into three main sections—an outer, ilio-costalis or sacro-lumbalis; an inner, spinalis dorsi; and an intermediate, longissimus dorsi. It arises, by a thick aponeurosis, from the spines of the lower two thoracic, from the lumbar, and upper four sacral vertebræ; from the back of the sacrum and the posterior sacro-iliac ligaments; and, by muscular fibers, from the posterior fifth of the crest of the ilium. The whole mass ascends, and divides below the last rib into three columns.

The **outer column** is subdivided into the ilio-costalis or sacro-lumbalis and its continuations—the accessorius ad ilio-costalem and the cervicalis ascendens muscle.

BLOOD SUPPLY.—From the posterior scapular, intercostal, and lumbar arteries.

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the lumbar, thoracic, and cervical regions.

The **ilio-costalis or sacro-lumbalis** is the outermost and fleshy part of the erector spinæ muscle, and is inserted into the angles of the ribs from the sixth to the eleventh, and into the inferior border of the twelfth, the transverse processes of the lumbar vertebræ, and into the middle layer of the lumbar fascia. Very often this muscle is inserted as high as the fourth rib.

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the lumbar and thoracic regions.

ACTION.—It depresses the ribs, and is, therefore, a muscle of expiration. It keeps the body erect by extending the spinal column, which it also flexes laterally.

DISSECTION.—Turn the ilio-costalis muscle outward to expose the origins of the accessorius muscle.

The **accessorius muscle** (accessorius ad ilio-costalem) is the upward continuation of the ilio-costalis muscle and arises, by tendinous slips, from the angles of the lower six ribs, internal to the costal insertions of the ilio-costalis muscle. It is

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the thoracic region.

ACTION.—With fixation of the lower six ribs by the ilio-costalis this muscle draws downward the upper six ribs, as in expiration. It also aids in extension and lateral flexion of the spinal column; acting from its insertion, it elevates the lower six ribs, as in inspiration.

The **cervicalis ascendens** is the continuation of the accessorius muscle and arises from the upper four or five ribs internal to the costal insertions of the accessorius muscle. It passes upward over the first rib and the transversalis colli muscle, and is inserted into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the thoracic and cervical regions.

ACTION.—It extends the neck and flexes it laterally. Acting from its insertion, it elevates the ribs to which it is attached, as in inspiration.

The **intermediate column** consists of the longissimus dorsi, transversalis colli, and trachelo-mastoid muscles.

BLOOD SUPPLY.—From the princeps cervicis, profunda cervicis, intercostal, and lumbar arteries.

The **longissimus dorsi muscle** is the largest of the erector spinæ group. Its inner side lies in close contact, in the lumbar region, with the spinalis dorsi muscle, from which it often receives a slip. It has two series of insertions—an inner, or vertebral; and an outer, or costal: the inner series, by rounded tendons, is attached to the transverse processes of all of the thoracic and the lumbar vertebræ; the outer series, by fleshy and tendinous slips, is inserted into all of the ribs external to the tubercles, the transverse processes of the lumbar vertebræ, and the adjacent portion of the middle lamella of the lumbar fascia.

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the lumbar and thoracic regions.

ACTION.—It extends the spinal column, flexes it laterally, and depresses the ribs, as in expiration.

The **transversalis colli muscle** is the upward continuation of the longissimus dorsi, and is situated upon the inner side of that muscle. It arises from the transverse processes of the upper five or six thoracic vertebræ, and is inserted into the posterior tubercles of the transverse processes of the cervical vertebræ from the

The **trachelo-mastoid muscle** is situated upon the inner side of the transversalis colli, and forms the continuation of that muscle toward the head. It arises from the transverse processes of the third, fourth, fifth, and sixth thoracic vertebræ and, by additional tendons, from the back of the articular processes of the lower three or four cervical vertebræ. It proceeds upward as a small muscle which is inserted into the posterior border of the mastoid process under the splenius and sterno-mastoid muscles. It has frequently a tendinous intersection near its insertion.

NERVE SUPPLY.—From the external branches of the posterior divisions of the spinal nerves in the thoracic and cervical regions.

ACTION.—It flexes the head laterally, rotates it to the same side, and with the aid of its fellow extends the head.

The **inner column** of the erector spinæ muscle consists of the **spinalis dorsi muscle.**

The **spinalis dorsi muscle** is the continuation of that portion of the erector spinæ muscle which arises from the upper two lumbar and lower two thoracic spines. It is inserted into the spines of the upper thoracic vertebræ, varying from four to eight in number. Its outer lower side is closely connected with the longissimus dorsi muscle, and, at its insertion, with the semi-spinalis dorsi muscle.

BLOOD SUPPLY.—From the intercostal and lumbar arteries.

NERVE SUPPLY.—From the posterior branches of the spinal nerves of the thoracic region.

ACTION.—It extends the spinal column and flexes it laterally.

The **spinalis colli muscle,** analogous to the spinalis dorsi muscle, generally extends from the fifth and sixth cervical spines to the spine of the axis. It varies considerably, and may be attached to two additional spines below the origin and insertion here given. This muscle is not present in all subjects.

NERVE SUPPLY.—From the posterior branches of the cervical nerves.

ACTION.—It extends the neck and inclines it laterally.

The **complexus** is a broad, bulky muscle occupying the cervical and upper thoracic regions, and passing upward and inward to the occipital bone. It arises from the posterior surface of the transverse processes of the upper six thoracic and the last cervical vertebræ, the posterior surface of the articular processes of the cervical vertebræ (third to the sixth) and the spine of the seventh cervical vertebra. It is inserted into the occipital bone between the superior and inferior curved lines.

transversalis colli muscles. It lies upon the obliquus capitis superioris and inferioris muscles, the rectus capitis posticus major and minor muscles, the semi-spinalis colli muscle, the profunda cervicis and princeps cervicis arteries, and the posterior division of the spinal nerves, including the great occipital nerve which pierces it.

Blood Supply.—From the profunda cervicis, princeps cervicis, and superficial cervical arteries.

Nerve Supply.—From the suboccipital, great occipital, and the internal branches of the posterior divisions of the third, fourth, and fifth cervical nerves.

Action.—It is a powerful extensor of the head and neck, flexes the head laterally, and turns the face slightly to the opposite side.

The **biventer cervicis,** which is the innermost portion of the complexus, is a small, delicate, double-bellied muscle.

Dissection.—The attachments of the erector spinæ and the spinalis dorsi muscles to the spines of the vertebræ and the insertions of the longissimus dorsi and the ilio-costalis muscles should be severed, and the muscles reflected downward. Next detach the accessorius, the cervicalis ascendens, the transversalis colli, and the trachelo-mastoid muscle. Sever the complexus muscle where the great occipital nerve pierces it, preserving that nerve intact; reflect the two portions, when the suboccipital and the other nerves which enter its deep surface will be brought into view.

In reflecting the trachelo-mastoid and the complexus muscle avoid injuring the occipital, princeps cervicis, and profunda cervicis arteries, and the deep cervical vein.

The **occipital artery** in the deepest part of its course will be found beneath the mastoid process of the temporal bone. At this point it is covered by the origin of the posterior belly of the digastric muscle, the mastoid process, the trachelo-mastoid, splenius capitis and sterno-mastoid muscles. This artery winds through the interval between the mastoid process of the temporal bone and the transverse process of the atlas; it is separated from the vertebral artery by the rectus capitis lateralis muscle, and then traverses the occipital groove upon the mastoid portion of the temporal bone. It crosses the superior oblique and a portion of the complexus muscle and at the posterior border of the splenius pierces the trapezius muscle together with the great occipital nerve. The vessels arising from this

downward between the complexus and semi-spinalis colli muscles and anastomoses with the profunda cervicis artery and some small branches of the vertebral artery.

The **mastoid branch** passes through the mastoid foramen to supply the mastoid cells, the diploë, the walls of the lateral sinus, and the dura mater.

The **muscular branches** supply adjacent muscles.

The **profunda cervicis artery,** a branch of the superior intercostal, emerges from between the transverse process of the last cervical vertebra and the neck of the first rib, and, passing upward between the complexus and the semi-spinalis colli muscle anastomoses with the princeps cervicis artery and branches of the ascending cervical and vertebral arteries.

The **deep cervical vein** is formed by small veins in the suboccipital triangle, usually receives the occipital vein, accompanies the princeps cervicis and then the profunda cervicis artery, and empties into the vertebral or innominate vein.

The previous dissection exposed the deepest muscles of the back; these are, from below upward, the following: The multifidus spinæ, the levatores costarum, semi-spinalis dorsi, semi-spinalis colli, the obliquus capitis superioris and inferioris, the rectus capitis posticus major and minor. The middle layer of the lumbar fascia, the occipital, the princeps cervicis, and the profunda cervicis arteries, the great occipital and suboccipital nerves, and the suboccipital triangle were also revealed.

Blood Supply.—These deep muscles are nourished by the vertebral, princeps cervicis, profunda cervicis, intercostal, and lumbar arteries.

The **semi-spinalis dorsi muscle** is composed of small, fleshy bellies uniting rather long tendons. It arises from the transverse processes of the fifth to the tenth thoracic vertebræ, and is inserted into the spines of the upper four thoracic and lower two cervical vertebræ. It is covered by the longissimus dorsi and the spinalis dorsi muscle, and rests upon the multifidus spinæ muscle.

Nerve Supply.—From the internal branches of the posterior divisions of the spinal nerves.

Action.—It is an extensor and lateral flexor of the spinal column.

The **semi-spinalis colli muscle** is thicker and shorter than the semi-spinalis dorsi. It arises from the transverse processes of the upper five or six thoracic vertebræ, and is inserted into the spines of the second to the fifth (inclusive) cervical vertebræ. It is covered by the branches of the posterior division of the

ACTION.—It is an extensor and lateral flexor of the cervical portion of the spinal column.

The **levatores costarum muscles** arise from the tips of the transverse processes of the last cervical and all of the thoracic vertebræ except the twelfth, and are inserted into the upper border and outer surface of the next rib below, between the tubercle and angle. The lower levatores divide into two slips, the additional one going to the second rib below. They lie external to the semi-spinalis dorsi muscle.

NERVE SUPPLY.—From the intercostal nerves.

ACTION.—The levatores, as indicated by their name, elevate the ribs, thus assisting the external intercostal muscles.

The **multifidus spinæ muscle** is situated in the groove at the side of the spinous processes, under the semi-spinalis muscle, and extends from the axis to the sacrum. The fibers arise from the groove on the dorsal aspect of the sacrum, the posterior superior spine of the ilium, the posterior sacro-iliac ligament, and the deep surface of the aponeurotic origin of the erector spinæ muscle. In the lumbar region the fibers arise from the mammillary processes; in the thoracic, from the transverse processes; and in the cervical, from the articular processes of the lower four vertebræ. From these numerous points of origin the muscular bundles pass upward in an oblique direction, and are attached to the spinous processes and laminæ of the vertebræ; the most superficial bundles are the longest, and pass to the third or fourth vertebra above their origin; while the deeper ones pass to the next vertebra and to the second or third above.

NERVE SUPPLY.—From the internal branches of the posterior divisions of the spinal nerves.

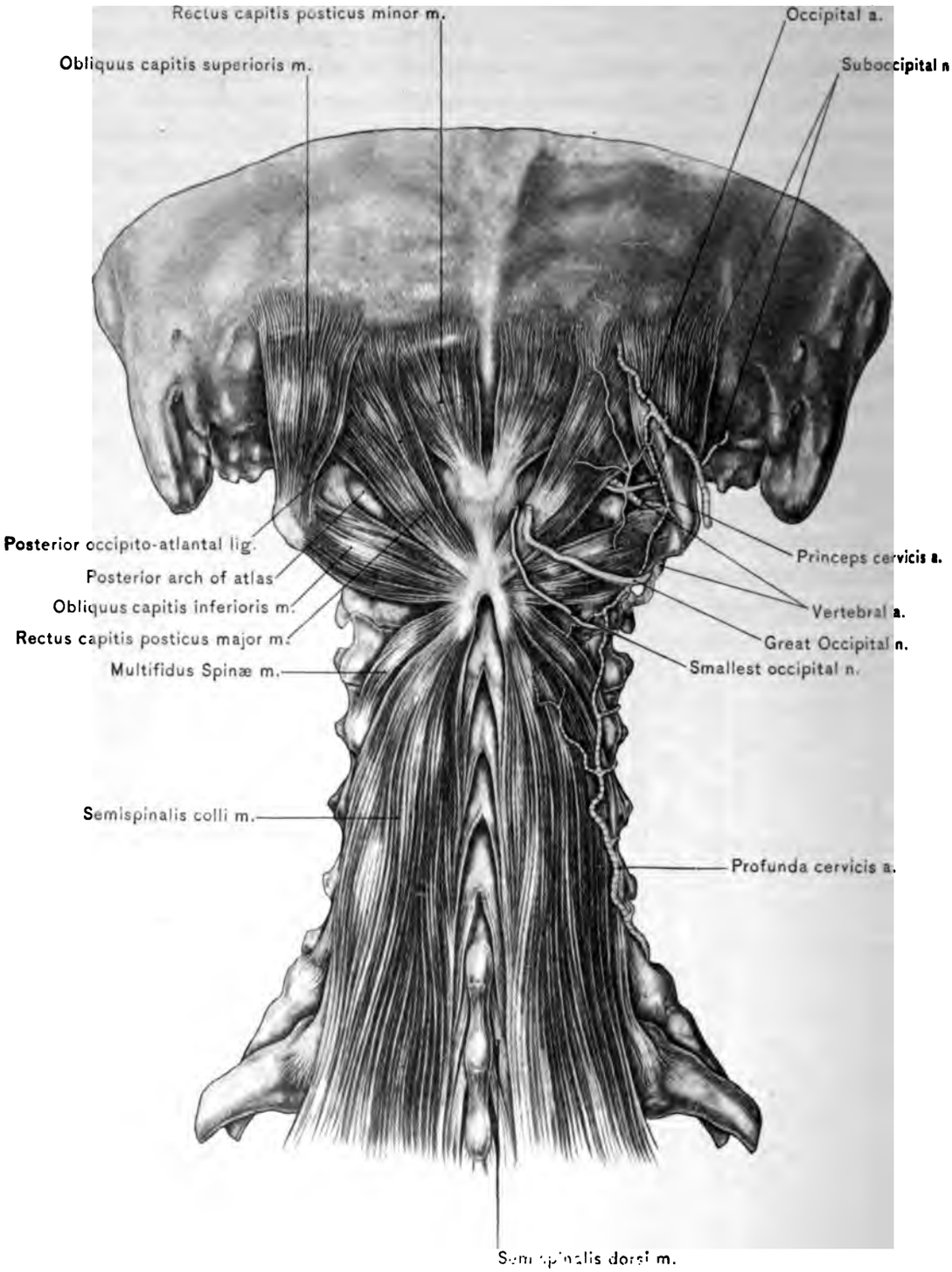
The **rotatores spinæ,** situated under the multifidus spinæ muscle, are eleven small quadrilateral muscles, each of which arises from the upper back part of a transverse process of a thoracic vertebra, and ascends to be inserted into the lower margin and outer surface of the lamina of the vertebra immediately above, extending as far inward as the base of the spinous process.

NERVE SUPPLY.—From the internal branches of the posterior divisions of the spinal nerves.

ACTION.—They rotate the spinal column, turning the body of the vertebra toward the opposite side; and, acting bilaterally, extend the spinal column.

The **interspinales muscles** extend in pairs between contiguous vertebral spines, the muscles of the two sides being separated by the interspinous ligaments. There are six *cervical* pairs between the axis and the first thoracic vertebra, and these are the most distinct. Two or three *thoracic* pairs are found between the first and second thoracic spines above and the eleventh and twelfth below, and

PLATE CIX.


Rectus capitis posticus minor m.
Occipital a.
Obliquus capitis superioris m.
Suboccipital n
Posterior occipito-atlantal lig.
Princeps cervicis a.
Posterior arch of atlas
Vertebral a.
Obliquus capitis inferioris m.
Great Occipital n.
Rectus capitis posticus major m.
Smallest occipital n.
Multifidus Spinæ m.
Semispinalis colli m.
Profunda cervicis a.
Semispinalis dorsi m.

occasionally a pair may be found between the second and third thoracic spines. There are four *lumbar* pairs between the five lumbar spines. Sometimes there are pairs above the first and below the last lumbar spine.

NERVE SUPPLY.—From the internal branches of the posterior divisions of the spinal nerves.

ACTION.—They assist, to a slight degree, in extending the spinal column.

The **intertransversales muscles** lie between the transverse processes of adjacent vertebræ. There are seven *pairs of cervical intertransversales* muscles on each side of the spinal column. They are found between the two adjacent anterior and two adjacent posterior tubercles, and are separated by the anterior branch of the cervical nerve emerging from the corresponding intervertebral foramen. They extend from the atlas to the first thoracic vertebra. The rectus capitis lateralis, extending between the jugular process of the occipital bone and the transverse process of the atlas, corresponds to an intertransversalis muscle.

The *thoracic intertransversales* muscles are found only in the lower three intervals.

There are four pairs of *lumbar intertransversales* muscles; of each pair, one muscle connects the ends of the transverse processes, and the other the accessory tubercle of one vertebra to the mammillary tubercle of the next vertebra below.

NERVE SUPPLY.—From the spinal nerves as they emerge from the intervertebral foramina.

ACTION.—They are lateral flexors of the spinal column.

MOVEMENTS.—It will be noticed that the muscles which permit movement of the spinal column, or rather which protect it against the effect of too sudden and extensive motion, are diminutive or absent in the thoracic region,—the least movable division of the spinal column,—and are better developed in the lumbar and cervical regions, where motion is much more free. Again, in the neck, where the movements are more intricate, these muscles are more numerous, and in the

suboccipital, nerve. The *vertebral artery* in the suboccipital triangle is seen emerging from the transverse process of the atlas and running above its posterior arch. It leaves the triangle by piercing the posterior occipito-atlantal ligament. The *suboccipital nerve* passes through the posterior occipito-atlantal ligament and between the vertebral artery and the posterior arch of the atlas. It is small and supplies the posterior recti, the obliqui, and the complexus muscle.

The **rectus capitis posticus major muscle,** cone-shaped, arises by its apex from the spine of the axis, passes upward, outward, and backward, and is inserted by its base into the inferior curved line of the occipital bone and the surface immediately below it. It is covered by the complexus muscle, and, at its insertion, by the superior oblique muscle; it rests upon the posterior arch of the atlas, the occipital bone, the posterior occipito-atlantal ligament, and the rectus capitis posticus minor muscle.

NERVE SUPPLY.—From the suboccipital nerve.

ACTION.—It extends the head and rotates it to the same side.

The **rectus capitis posticus minor muscle,** triangular in shape, arises by its apex from the tubercle upon the posterior arch of the atlas and ascends directly upward. It is inserted into the inferior curved line of the occipital bone and the surface immediately below it. It is covered by the complexus and the rectus capitis posticus major muscle, and lies upon the posterior occipito-atlantal ligament.

NERVE SUPPLY.—From the suboccipital nerve.

ACTION.—It extends the head.

The **obliquus capitis superioris muscle,** also triangular in shape, is smaller than the inferior oblique muscle. It arises by its apex from the back of the upper surface of the transverse process of the atlas, and passes upward and backward. It is inserted into the occipital bone between the two curved lines beneath the complexus muscles. It is covered by the complexus, the trachelo-mastoid, and the splenius muscles, and rests upon the rectus capitis posticus major muscle, vertebral artery, and posterior occipito-atlantal ligament.

NERVE SUPPLY.—From the suboccipital nerve.

ACTION.—It extends the head, flexes it laterally, and rotates the face to the opposite side.

The **obliquus capitis inferioris muscle,** larger than the superior oblique

NERVE SUPPLY.—From the suboccipital nerve.

ACTION.—It rotates the atlas upon the axis, carrying the face to the same side.

The **lumbar fascia** is a dense aponeurotic structure seen in the space between the last rib and the crest of the ilium. It assists in supporting the muscles of the loin, and gives partial origin to the internal oblique and transversalis muscles of the abdominal wall. It is attached above to the last rib and the cartilage of the eleventh rib, and below to the posterior one-third of the crest of the ilium. Internally, it divides into three layers. The *posterior layer* passes behind the erector spinæ muscle and blends with the aponeuroses of the latissimus dorsi and serratus posticus inferioris muscles, which aponeuroses are continued upward as the vertebral fascia. This division of the lumbar fascia is attached to the spines of the lower thoracic, lumbar, and sacral vertebræ. The *middle layer* passes between the erector spinæ muscle and the quadratus lumborum, and is attached to the tips of the transverse processes of the lumbar vertebræ. The *anterior layer* passes in front of the quadratus lumborum, and is attached to the anterior surface of the bases of the transverse processes of the lumbar vertebræ. The upper portion of the anterior layer which extends between the transverse process of the first lumbar vertebra and the tip and lower border of the last rib is called the *ligamentum arcuatum externum*. The lumbar fascia is overlapped to the outer side of the erector spinæ muscle by the latissimus dorsi and external oblique muscles. It is an important guide in operations upon the kidney or colon through the loin.

In lumbar abscess, pointing at Petit's triangle, the pus burrows through the middle and posterior lamellæ of the lumbar fascia.

The **nerves of the back** are derived from the posterior primary divisions of the spinal nerves. With the exception of the first and second cervical nerves, the posterior primary are smaller than the anterior primary divisions.

The **posterior primary division of the first cervical nerve (suboccipital)** runs backward, pierces the occipito-atlantal ligament, passes between the vertebral artery and the posterior arch of the atlas and through the suboccipital triangle. It supplies twigs to the rectus capitis posticus major and minor muscles, the

the lower border of the inferior oblique muscle and under cover of the complexus. It crosses over the suboccipital triangle, pierces the complexus muscle—which it supplies—and the outer border of the trapezius near the superior curved line of the occipital bone. It then ramifies in the superficial fascia of the back of the scalp with the occipital artery.

The **posterior divisions of the third, fourth, and fifth cervical nerves** pass backward at the outer border of the semi-spinalis colli muscle, and divide into external and internal branches. The *external branches* supply the splenius, the trachelo-mastoid, the cervicalis ascendens, and the transversalis colli muscle. The *internal branches* supply the semi-spinalis colli and the complexus muscle, between which they lie, and send branches to the multifidus spinæ. They next pass between the complexus muscle and the ligamentum nuchæ, pierce the origin of the trapezius muscle, and are distributed to the integument of the back of the neck.

The **smallest occipital nerve** is the internal branch of the posterior division of the third cervical nerve. It passes upward and communicates with the great occipital nerve.

The **external branches of the posterior divisions of the sixth, seventh, and eighth cervical nerves** supply the splenius, the complexus, the cervicalis ascendens, and the transversalis colli muscle. The **internal branches** supply the semi-spinalis colli and the multifidus spinæ muscle.

The **posterior primary divisions of the thoracic nerves** pass backward between the transverse processes of the thoracic vertebræ. They then divide into external and internal branches, the former increasing and the latter decreasing in size from the second to the last.

The *external branches* of the posterior divisions of the upper six or seven thoracic nerves terminate in the longissimus dorsi and accessorius muscles. The lower five or six pierce the outer insertions of the longissimus dorsi, and are then found between that muscle and the accessorius. After piercing the latissimus dorsi muscle they reach the integument of the lower and outer part of the back.

The *internal branches* supply the longissimus dorsi, the spinalis dorsi, the semi-spinalis dorsi, the multifidus spinæ, the rotatores spinæ, the intertransversales,

external branch of the fourth lumbar nerve supplies, and that of the fifth passes to, the erector spinæ muscle; the last communicates with the first sacral nerve.

The **posterior primary divisions of the upper four sacral nerves** emerge at the posterior sacral foramina; that division of the fifth sacral nerve emerges at a point between the sacrum and coccyx, and the coccygeal nerve issues from the lower opening of the spinal canal.

The **posterior divisions of the upper three sacral nerves** divide into external and internal branches, while the lower two sacral and the coccygeal nerve remain undivided. The *external branches* of the posterior divisions of the upper three sacral nerves form loops between themselves and the external branch of the last lumbar nerve on the back of the sacrum, and form a second series of loops on the posterior surface of the great sacro-sciatic ligament. From these loops are derived two or three nerves which pierce the gluteus maximus muscle to supply the integument. The *internal branches* of the posterior division of the upper three sacral nerves supply the multifidus spinæ muscle. The posterior divisions of the lower two sacral nerves form loops with the coccygeal nerve and the posterior branch of the third sacral nerve. Branches from these loops supply the skin over the coccyx.

A careful study of the groups of muscles of the back will reveal the fact that their arrangement is simpler than is generally supposed. The five axo-appendicular muscles—*i. e.*, the trapezius, latissimus dorsi, levator anguli scapulæ, and the two rhomboidei—are well known. The two posterior serrati muscles are not readily forgotten. The deep cranio-vertebral group, the two recti and the two oblique muscles, are interesting and easily understood and remembered. The erector spinæ muscle, with its three upward extensions, like a spreading vine, picking its way, hand over hand, as it were, from rib to rib, by regular intervals, is not difficult to master: The inner stem being the spinalis dorsi muscle, the middle consisting of the longissimus dorsi, the transversalis colli, and the trachelo-mastoid muscle; and the outer stem being composed of the ilio-costalis, the accessorius ad ilio-costalem, and the cervicalis ascendens muscle. The complexus and the biventer cervicis really form but one muscle. The semi-spinales dorsi and colli muscles—extending by long fibers from the transverse to the spinous pro-

LIGAMENTS OF THE VERTEBRAL COLUMN.

The ligaments uniting the vertebræ may be divided as follows: Those connecting the bodies; the laminæ; the spinous processes; the transverse processes, and the articular processes of the vertebræ.

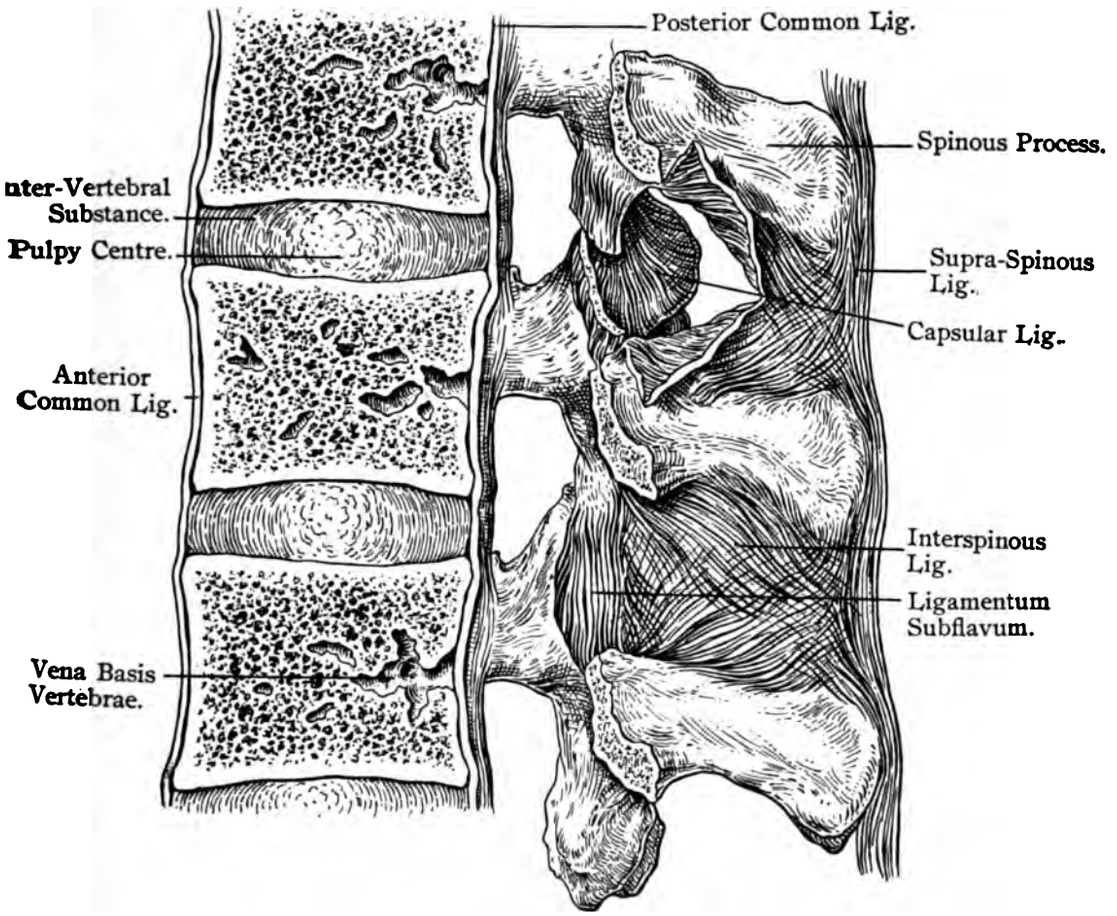
The **Ligaments which Unite the Bodies of the Vertebræ** are the anterior and posterior common ligaments, the intervertebral discs, and the lateral vertebral ligaments.

The **anterior common ligament** is a fibrous band which is situated upon the anterior surface of the bodies of the vertebræ, and extends from the tubercle upon the anterior arch of the atlas to the front of the middle piece of the sacrum. Above, it is narrow and forms the central portion of the atlanto-axoid ligament. As it descends it broadens and forms a glistening white investment for the anterior surface of the bodies of the vertebræ. Below, it is attached to the front of the sacrum, and is lost in the periosteum of that bone. It is continued as the anterior sacro-coccygeal ligament. The ligament is composed of numerous fibers of various lengths. The most superficial fibers extend over four or five consecutive vertebræ, deeper ones over two or three vertebræ, and the deepest connect adjacent vertebræ. The fibers of these different lengths are so interlaced that it is impossible to separate the ligament into these three sets of fibers. The ligament is closely attached to the intervertebral discs and the edges of the bodies of the vertebræ, but is not so firmly united with the intermediate portion of the bodies. It is thickest in the thoracic region, and in the lumbar is thicker than in the cervical region.

The **posterior common ligament** is located upon the posterior surface of the bodies of the vertebræ and lines the anterior wall of the spinal canal. It extends from the basilar groove of the occipital bone to the coccyx; is broader above than below, and thickest in the thoracic region; presenting opposite the intervertebral discs lateral expansions which give it a dentated appearance. Between the ligament and the middle of the posterior surface of bodies of the vertebræ is an interval which is occupied by some areolar tissue and vessels to the bodies of the vertebræ. The filum terminale of the spinal cord blends with the ligament at the back of the base of the coccyx. The more superficial fibers extend between three or four vertebræ, and the deeper ones between adjacent vertebræ.

The **intervertebral substance or intervertebral discs** are twenty-three in number, situated between the adjacent surfaces of the bodies of the vertebræ from the axis to the sacrum. They are tough, elastic, and compressible, and form the chief bond of union between the vertebræ. In the sacral region they are more or less completely ossified. They are flattened or rather wedge-shaped, and their outline corresponds to that of the adjacent vertebral bodies. In the thoracic region

PLATE CX.


Posterior Common Lig.
Spinous Process.
nter-Vertebral Substance.
Pulpy Centre.
Supra-Spinous Lig.
Capsular Lig.
Anterior Common Lig.
Interspinous Lig.
Ligamentum Subflavum.
Vena Basis Vertebrae.

their thickness is nearly uniform, and the thoracic curve is chiefly formed by the bodies of the vertebræ, and in the cervical and lumbar regions their greater thickness in front assists in forming the curves of those portions of the spinal column. They form about one-fourth of the length of the spinal column, and are thickest and largest in the lumbar region. When they are shrunken or compressed, as in old persons or laborers, the spinal column shortens and bends forward. They are composed of a firm ring of fibro-cartilaginous tissue and a central pulpy substance. The fibro-cartilaginous tissue is arranged in concentric laminæ, the fibers of which pass obliquely from one surface of the disc to the other. The directions of the fibers of the two adjacent laminæ are not parallel, but form angles like the limbs of the letter X. The central substance of the discs is of a pulpy consistency, and is composed of a fine connective-tissue matrix which contains cartilage cells in its meshes.

The **lateral or short vertebral ligaments** connect the adjacent margins of the bodies of the vertebræ in the interval between the anterior and posterior common ligaments, with which they are continuous. They are best developed in the thoracic and lumbar regions.

The **Laminæ** are connected by the ligamenta subflava.

The **ligamenta subflava** are found in the spaces between and connecting the laminæ of the vertebræ. The first of these ligaments extends from the axis to the third cervical vertebra, the two spaces above being filled by the posterior occipito-atlantal and posterior atlanto-axoid ligaments. The ligamenta subflava are attached, above, to the inner surface of the inferior articular process and the inner surface of the lower margin of the lamina of the vertebra; below, to the inner surface of the superior articular process and the upper margin of the lamina. Each ligament extends from the articular processes of one side to those of the opposite side, forming one broad, short ligament. These ligaments assist in forming the capsular ligaments, which connect the articular processes and are continuous with the interspinous ligaments at the roots of the spinous processes. They are strongest in the lumbar region, of greater strength in the thoracic

ligaments closes in the lower end of the spinal canal, and is attached to the back of the coccyx.

The **interspinous ligaments** are thin, membranous sheets which connect adjacent spinous processes of the vertebræ. The fibers of each ligament decussate. They are stronger in the lumbar than in the thoracic region, and in the cervical region are delicate and supported by the *interspinales* muscles.

The **Transverse Processes** are connected by the intertransverse ligaments.

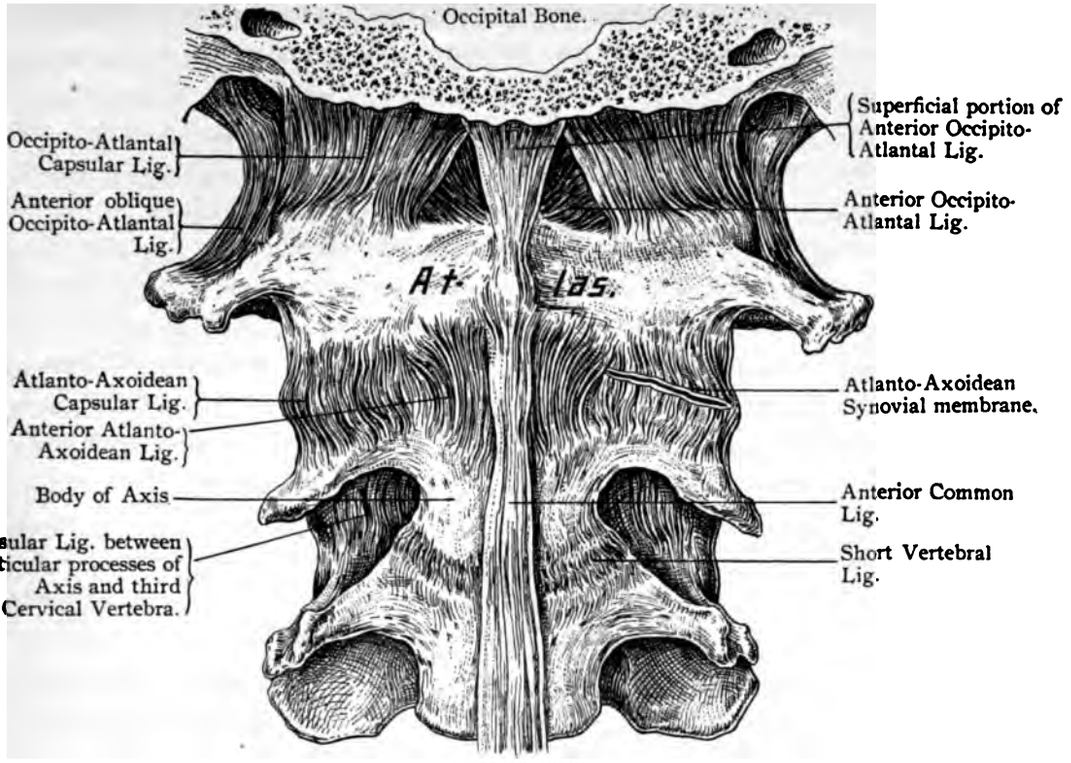
The **intertransverse ligaments** pass between the tips of the transverse processes. In the thoracic region they are weak bands; in the lumbar region they are weak and membranous; and in the cervical region they are replaced by the intertransversales muscles.

The **Articular Processes** are connected by capsular ligaments.

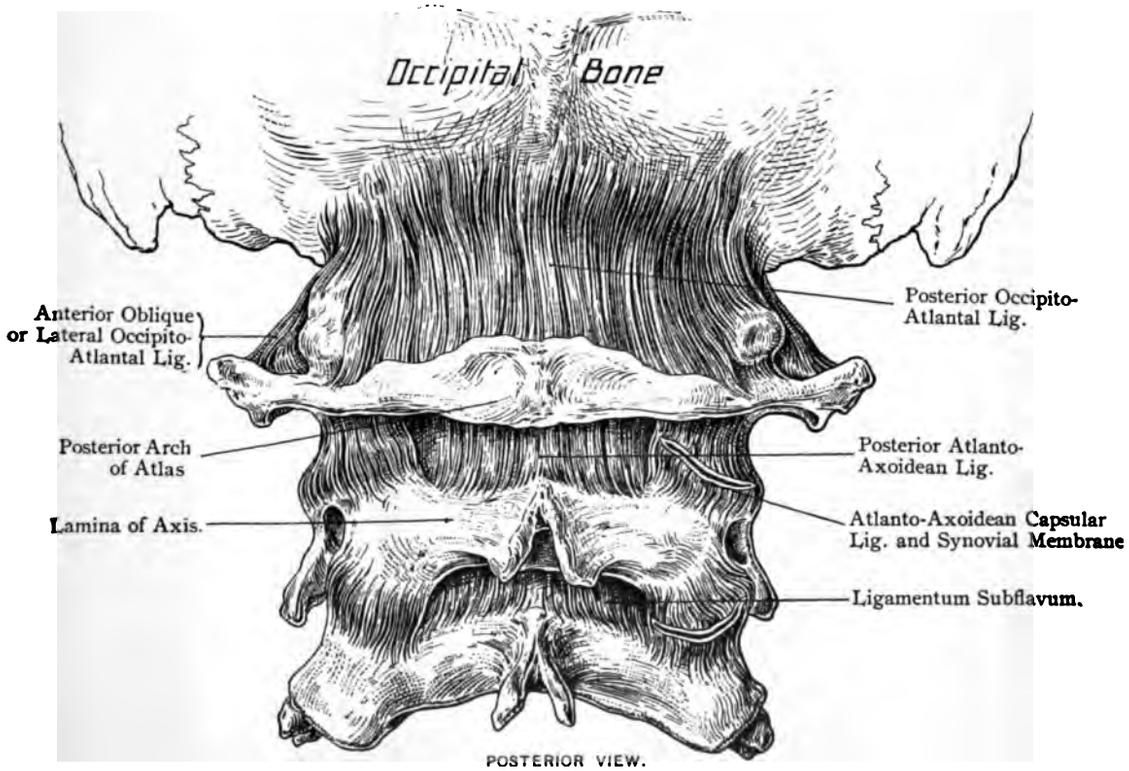
The **capsular ligaments** connect adjacent articular processes and are attached along the margins of the articulating surfaces. Their inner portion is formed by the lateral part of the ligamenta subflava. In the cervical region they are loose; in the lumbar region not so lax; and in the thoracic region short and tight. Each joint is lined by one synovial membrane.

Movements.—The spinal column is the axis of the skeleton; it supports the cranium, upper extremities, and part of the trunk, and is supported by the pelvis and lower extremities. It is composed of a number of bones, one superimposed upon another and bound together by numerous strong ligaments. When assisted by the surrounding muscles, it is capable of sustaining great weight, and by means of their elasticity the intervertebral discs diminish or prevent the transmission of shock. Although the vertebræ are firmly united and there is little movement between adjacent vertebræ, the spinal column is quite flexible and capable of many movements; these are possible on account of the elasticity of the intervertebral substance, and all occur around an axis which passes through the central pulpy substance of the intervertebral discs. The movements vary in different regions, and their freedom differs with the shape of the bodies, the articular, transverse, and spinous processes. The bodies and intervening discs are the chief supports of the superimposed weight, and the articular processes, assisted by the ligaments between the spines and between the transverse processes, steady the column. The movements are flexion, extension, lateral flexion, circumduction, and rotation.

In the **neck** there is little movement between the axis and the third cervical vertebra, but below this vertebra all movements are free in this region. **Flexion**



ANTERIOR VIEW.



POSTERIOR VIEW.

In the **lumbar region** all of the movements are comparatively free between the third and fourth, and fourth and fifth vertebræ.

As the forms of the joints between the occipital bone, atlas, and axis differ from those of the intervertebral joints below, they require a separate description.

The **Axis is Connected with the Atlas** by the anterior and posterior atlanto-axoid, two capsular, transverse, and atlanto-odontoid capsular ligaments, and between them are two lateral and one central atlanto-axoid joint.

The **anterior atlanto-axoid ligament** is a thin, fibro-elastic membrane. It is attached above to the anterior surface and lower border of the anterior arch of the atlas, and below to the base of the odontoid process and the transverse ridge on the front of the body of the axis. Its median portion is covered by the narrow upper end of the anterior common ligament, which, in this location, is sometimes called the **superficial anterior atlanto-axoid ligament.** On either side the atlanto-axoid ligament is continuous with the capsular ligaments. It is covered by the longus colli muscles.

The **posterior atlanto-axoid ligament** is a thin membrane which takes the place of the ligamenta subflava in this location. It is attached above to the posterior surface and lower margin of the posterior arch of the atlas and below to the dorsal aspect of the superior margins of the lamina of the axis. On either side it extends to the posterior roots of the transverse processes, and is continuous with the capsular ligaments. It is covered by the rectus capitis posticus major and obliquus capitis inferioris muscles.

The **lateral atlanto-axoid joints** are formed by the articulation of the superior articular processes of the axis with the inferior articular surface of the lateral mass of the atlas. Each joint has a loose *capsular ligament* and one synovial sac. The ligaments are strengthened in front and behind by the anterior and posterior atlanto-axoidean ligaments.

The **central atlanto-axoid joint** is divisible into two joints—one between the odontoid process of the axis and the transverse ligament (syndesmo-odontoid) and the other between the odontoid process and anterior arch of the atlas (atlanto-odontoid). Each of these joints has a synovial membrane. The synovial sac of the syndesmo-odontoid joint is limited by a fibrous membrane which passes from

ment is continuous with the occipito-atlantal capsular ligaments. At the margins of the arch of the atlas it blends with the central occipito-odontoid, anterior occipito-atlantal, and anterior atlanto-axoid ligaments.

The **transverse ligament** is a strong, closely woven, fibrous band which passes across the large central opening in the arch of the atlas, and divides it into a small anterior portion—through which the odontoid process projects—and a large posterior part, which is the upper continuation of the spinal canal and transmits the spinal cord, its membranes, and the spinal portion of the spinal accessory nerves. Upon each side the transverse ligament is attached to the tubercle upon the inner surface of the lateral mass of the atlas. A vertical band of fibers, placed immediately behind the transverse ligament, passes from the back part of the base of the odontoid process to the occipital bone. This band is strengthened by fibers, some of which pass upward and others downward from the transverse ligament. The transverse ligament and the vertical band form a **crucial ligament.** The anterior surface of the transverse ligament is smooth and in relation with the syndesmo-odontoid synovial membrane. The lower margin of the ligament is closely apposed to the neck of the odontoid process and thus firmly suspends that process in place.

MOVEMENTS.—The movements between the atlas and axis are necessarily chiefly in a rotatory direction. These movements are limited by the occipito-axoid (check) and the atlanto-axoid ligaments. The movement in the lateral atlanto-axoid joints is of a gliding character. There is also slight antero-posterior and lateral flexion.

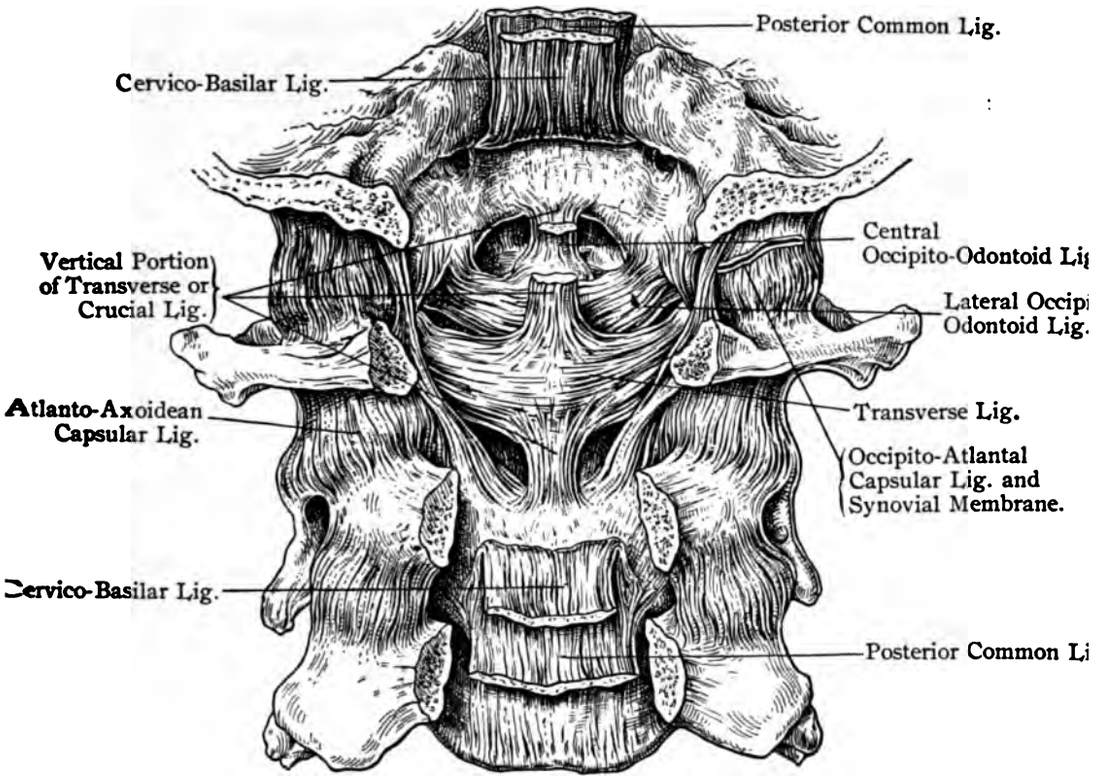
The **Ligaments which Connect the Axis with the Occipital Bone** are the occipito-cervical, crucial, and three odontoid ligaments.

The **occipito-cervical, cervico-basilar, or occipito-axoid ligament** is the upper portion of the posterior common ligament, some of the fibers of which are not attached to the axis but pass upward to the occipital bone. The ligament is attached below to the posterior surface of the body of the axis from the root of the odontoid process downward, and its lower attachment also extends to the upper part of the body of the third cervical vertebra. Above, it is attached to the basilar groove of the occipital bone. It is narrow at the body of the axis and gradually broadens above. It is in relation in front with the crucial ligament, and behind with the dura mater of the spinal cord, and is exposed by removing the spines and laminæ of the atlas and axis.

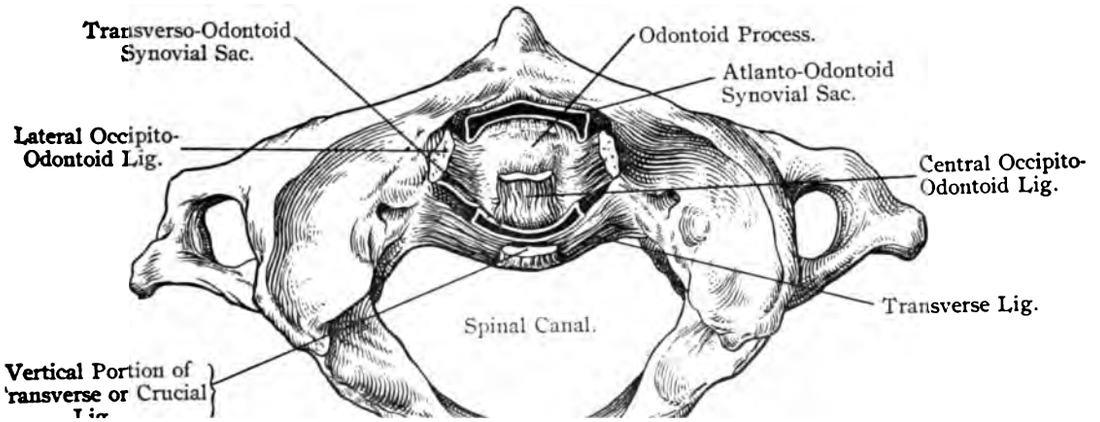
The **crucial ligament** is described with the transverse ligament.

The **odontoid ligaments** connect the odontoid process with the occipital bone. They are three in number—viz., a central and two lateral.

The *central odontoid ligament, or suspensory ligament,* is attached below to the



LIGAMENTS IN POSTERIOR SURFACE OF UPPER PART OF ANTERIOR WALL OF SPINAL CANAL.



tip of the odontoid process and above to the under surface of the anterior margin of the foramen magnum. It is a slender band which is located between the two lateral odontoid ligaments. It is in relation in front with the anterior occipito-atlantal, and behind with the upper division of the crucial ligament.

The *lateral odontoid, or check, ligaments* are strong, rounded bands which pass almost transversely outward and slightly upward from the sides of the apex of the odontoid process to the rough depressions upon the inner surfaces of the condyles of the occipital bone.

The **Ligaments which Connect the Atlas with the Occipital Bone** are the anterior and posterior occipito-atlantal, two capsular, and two lateral occipito-atlantal ligaments.

The **anterior occipito-atlantal ligament** is attached below to the upper margin of the anterior arch of the atlas, and above to the anterior margin of the foramen magnum. Its central portion is thick and strong, and is the upward continuation of the anterior common ligament. The lateral portions of the ligament are thinner and continuous with the capsular ligaments. It is covered in front by the rectus capitis anticus minor muscles. Behind it are the odontoid ligaments.

The **posterior occipito-atlantal ligament** is a thin membrane and corresponds to the ligamenta subflava, but contains no elastic tissue. Its laxity, however, permits free motion. The ligament is attached below to the posterior surface and upper margin of the posterior arch of the atlas, and above to the posterior margin of the foramen magnum from one condyle to the other. Upon each side its lower and outer portion contains an opening close to the arch of the atlas. This opening gives passage to the vertebral artery and suboccipital nerve. In front the ligament is in relation with the dura mater, and behind with the rectus capitis posticus minor and superior oblique muscles.

The **two capsular ligaments** are attached to the margins of the condyles of the occipital bone above, and below to the margins of the articular surfaces upon the upper aspect of the lateral mass of the atlas. These ligaments are lax and not very strong, and therefore do not add much strength to the joint. Each capsular ligament is lined with a synovial membrane which occasionally communicates with the synovial sac of the transverso-odontoid joint.

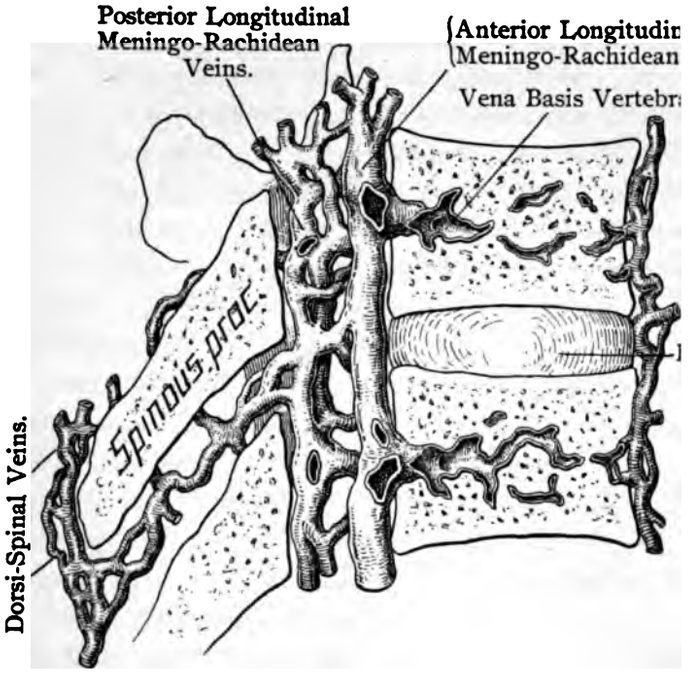
The **lateral occipito-atlantal or anterior oblique occipito-atlantal ligaments** are two strong fibrous bands placed upon the front of the external surface of the

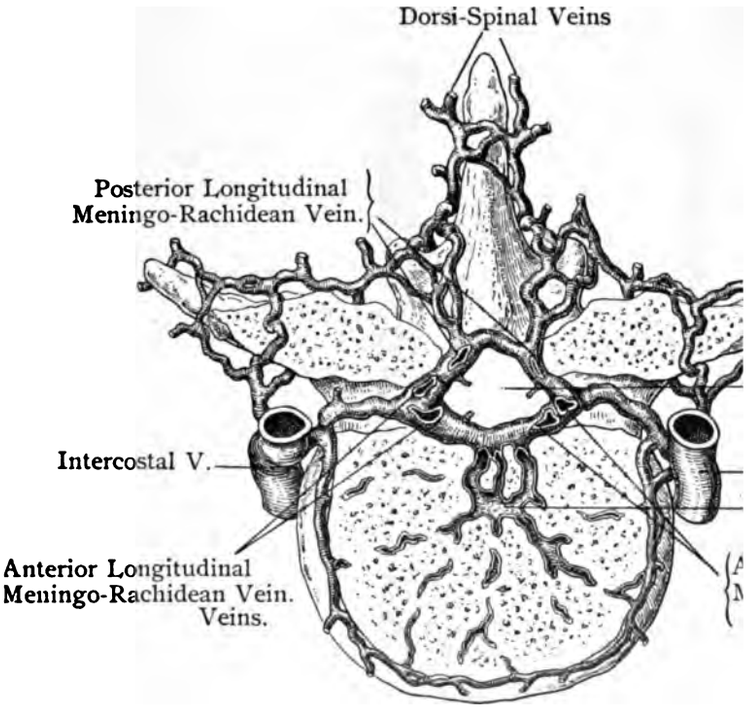
backward and forward, thus giving a limited nodding movement to the head. In more extensive forward and backward movements of the head the cervical portion of the spinal column is flexed and extended. There is also a very slight transverse and oblique gliding movement.

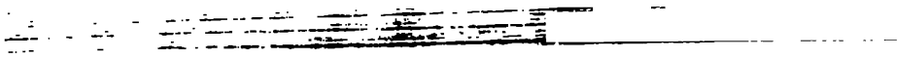
BLOOD SUPPLY.—The blood supply of the spinal column and its articulations is derived from the vertebral, occipital, ascending pharyngeal, ascending cervical, intercostal, lumbar, ilio-lumbar, sacra-media, and lateral sacral arteries.

NERVE SUPPLY.—From the spinal nerves.

Fractures and dislocations of the vertebra are most common in the cervical and lumbar regions where mobility of the spinal column is greatest. If displacement exists, the spinal cord is compressed, lacerated, or pulpified. Pressure upon or laceration of the motor tracts of the spinal cord causes loss of voluntary motion in muscles supplied by nerves which arise below the site of injury, because the motor cells of the cerebral cortex can not send impulses to the motor cells in or below the injured segments of the spinal cord. Sensation in the paralyzed parts is lost through involvement of the sensory tracts of the spinal cord and interruption of the impulses to the brain. Through pressure upon or rupture of the inhibitory nerves from the brain the reflexes are not controlled and are much exaggerated unless the lumbar enlargement be destroyed. Pressure upon the inhibitory nerves for this reason causes priapism. Through pressure upon the trophic nerves nutrition of the skin is imperfect and bed-sores develop. Loss of trophic and motor impulses allows degeneration and atrophy of the muscles. Through pressure upon the sensory and motor tracts fullness of the bladder causes no reflex act, and retention of urine results. After some time elapses the function of micturition may be performed through reflex action governed by the cells in the lower portion of the spinal cord. Paralysis of the sphincter ani causes incontinence of feces.


Posterior Longitudinal
Meningo-Rachidean
Veins.
Anterior Longitudin
Meningo-Rachidean
Vena Basis Vertebr
Spinous proc.
Dorsi-Spinal Veins.


Dorsi-Spinal Veins
Posterior Longitudinal
Meningo-Rachidean Vein.
Intercostal V.
Anterior Longitudinal
Meningo-Rachidean Vein.
Veins.



same portions of the last lumbar and first sacral vertebræ, should be divided with the knife, and the posterior wall of the canal lifted out. This will expose a quantity of loose areolar tissue and fat which contains plexuses of veins and some small arteries. Carefully remove the areolar tissue and fat.

The Spinal Arteries.—The blood supply of the spinal column, spinal ligaments, periosteum, and of the spinal cord and its membranes is derived from the spinal arteries which enter the canal through the intervertebral foramina. The spinal arteries in the cervical region are derived from the vertebral, ascending cervical, and profunda cervicis arteries; in the thoracic region, from the dorsal branches of the intercostal arteries; in the lumbar region from the posterior branches of the lumbar arteries; and in the sacral region from the lateral sacral arteries. The arrangement of the arteries after entering the spinal canal is similar in the different regions. Each spinal artery divides into three branches—one of which passes to the vertebral arches and ligamenta subflava; another pierces the dura mater above the corresponding spinal nerve, and supplies the spinal cord and its membranes; and a third passes to the posterior surface of the bodies of the vertebræ. The small plexuses of arteries seen on the posterior aspect of the bodies of the vertebræ are formed by the divisions of the third set of branches which anastomose with each other. These plexuses also give off branches which pass anteriorly around the wall of the canal to join branches from a median artery found on the posterior surface of the anterior common ligament.

The **Veins found Within the Spinal Canal** are the meningo-rachidian and the medulli-spinal veins. The **meningo-rachidian veins** lie in the extra-dural fat, and are arranged in two plexuses—one anterior and one posterior. The anterior plexus, of course, can not be studied until the spinal cord and its membranes have been removed from the spinal canal. It consists of two longitudinal veins which communicate freely with each other by means of transverse veins which pass beneath the posterior common ligament and receive the veins from the bodies of the vertebræ (venæ basis vertebræ). The anterior plexus communicates with the basilar and occipital sinuses. Near the arch of the atlas it gives off a branch which forms the origin of the vertebral vein. Other branches are given off near the intervertebral foramina, and accompany the spinal nerves. The posterior longitudinal plexus consists of two longitudinal veins or channels, placed upon

THE SPINAL CORD.

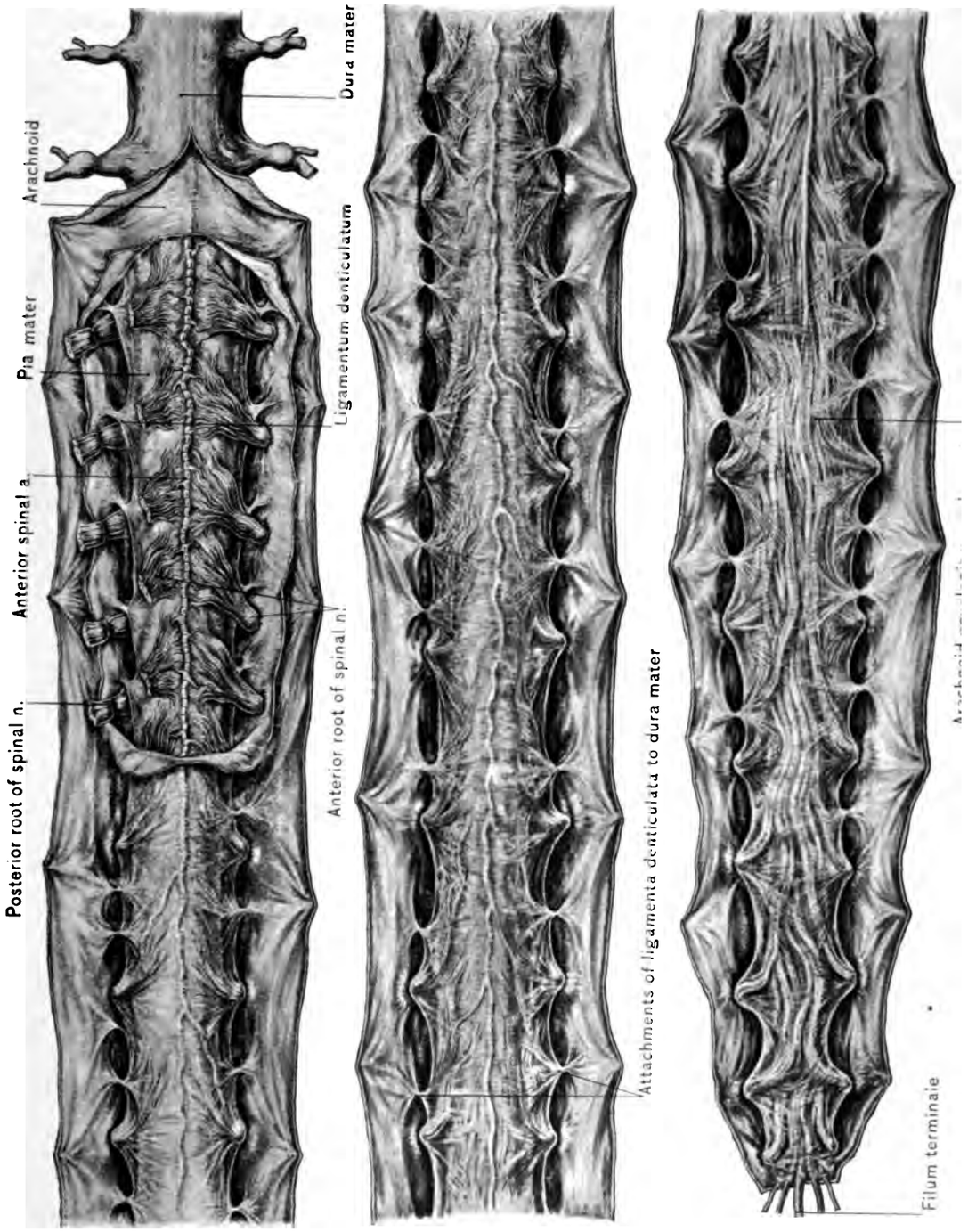
The spinal cord (medulla spinalis) is the continuation of the medulla oblongata. It extends from the lower border of the foramen magnum (below the decussation of the pyramids of the medulla) to the level of the upper border of the second lumbar vertebra; near its termination it assumes a conic shape,—the **conus medullaris,**—and terminates in a slender thread, the **filum terminale.** In the fetus the cord extends the entire length of the spinal canal, but does not in the adult, as the vertebral column grows more rapidly than the spinal cord. The length of the spinal cord in the adult is from sixteen to eighteen inches, and its average weight is about one and one-half ounces. It is a somewhat flattened cylinder, wider in the transverse diameter. In the thoracic region, however, it is almost cylindric in form. As it is lodged in the spinal canal, it follows the curves of the spinal column. It presents a cervical enlargement between the third cervical and second thoracic vertebræ, and a lumbar enlargement between the ninth thoracic and the first lumbar vertebra. The former enlargement is widest opposite the sixth cervical, and the latter opposite the twelfth thoracic vertebra. These enlargements occur where the large nerves are given off to supply the extremities.

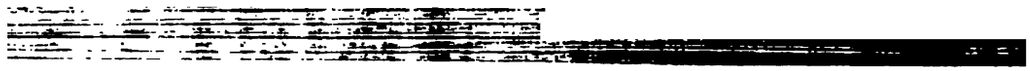
The Membranes of the Spinal Cord.—The membranes of the spinal cord are the dura mater, arachnoid, and pia mater. They are continuous with the corresponding membranes of the brain, and hold the same relation to each other as do those of the brain.

The **dura mater** is a non-adherent, dense, fibrous sheath which surrounds the spinal cord. It differs from the dura mater of the brain in that it does not form the internal periosteum of the spinal canal, nor the fibrous septa for the spinal cord; it does not contain sinuses, nor adhere to the walls of the canal. Like the dura mater of the brain, the dura mater of the spinal cord sends over the nerves tubular prolongations which become continuous with their sheaths.

The periosteum which lines the spinal canal is continuous with and represents the periosteal layer of the dura mater of the brain. The extra-dural veins of the spinal canal (meningo-rachidian) correspond in position to the sinuses of the dura mater of the brain. The dura mater is separated from the walls of the spinal

PLATE C.


Posterior root of spinal n.
Anterior spinal a.
Pia mater
Arachnoid
Dura mater
Ligamentum denticulatum
Anterior root of spinal n.
Attachments of ligamenta denticulata to dura mater
Filum terminale



ıe foramen magnum, to the axis, and third cervical vertebra; and below, to the ɔsterior surface of the base of the coccyx.

Dissection.—The spinal cord and its membranes should now be removed. o do this, divide the medulla oblongata and membranes of the cord at the foraıen magnum, and the spinal nerves as far outward in the intervertebral foramina ɜ possible, so as to preserve the ganglia on their posterior roots. If the cord be erfectly fresh, it should be hardened before its membranes are removed; but if ɔft, it should be dissected in plenty of water, which will protect it from pulpefacon. Incise the dura mater near its termination, and open it along its posterior ıedian surface with a pair of blunt-pointed scissors. Care must be taken to avoid ıjuring the subjacent arachnoid. Reflect the dura mater laterally, and note the ıining, inner surface. Note also that the spinal nerves as they leave the cord are ɑveloped by prolongations of the dura mater.

It will be seen that each nerve has a separate tubular prolongation of the ura mater, and that the anterior and posterior roots of the nerves are separated y a septum. The space exposed by reflecting the dura mater is known as the **ubdural space,** and lies between the dura mater and the arachnoid. It is proɔnged for a short distance upon the roots of the spinal nerves.

The arachnoid.—The arachnoid is a thin, delicate, veil-like membrane which ı continuous with the arachnoid of the brain, and lies between the dura and pia ıater. It is more delicate than that of the brain, but resembles the encephalic rachnoid in sending tubular prolongations along the nerves. It is attached to ıe dura mater behind by prolongations of connective tissue. These trabeculæ of ɔnnective tissue are not always demonstrable, and exist only in few and scattered laces. Below it is prolonged upon the cauda equina.

It will be noted that the arachnoid forms a long sac, the cavity of which es between the arachnoid and the pia mater, and is known as the **subarachnoid**

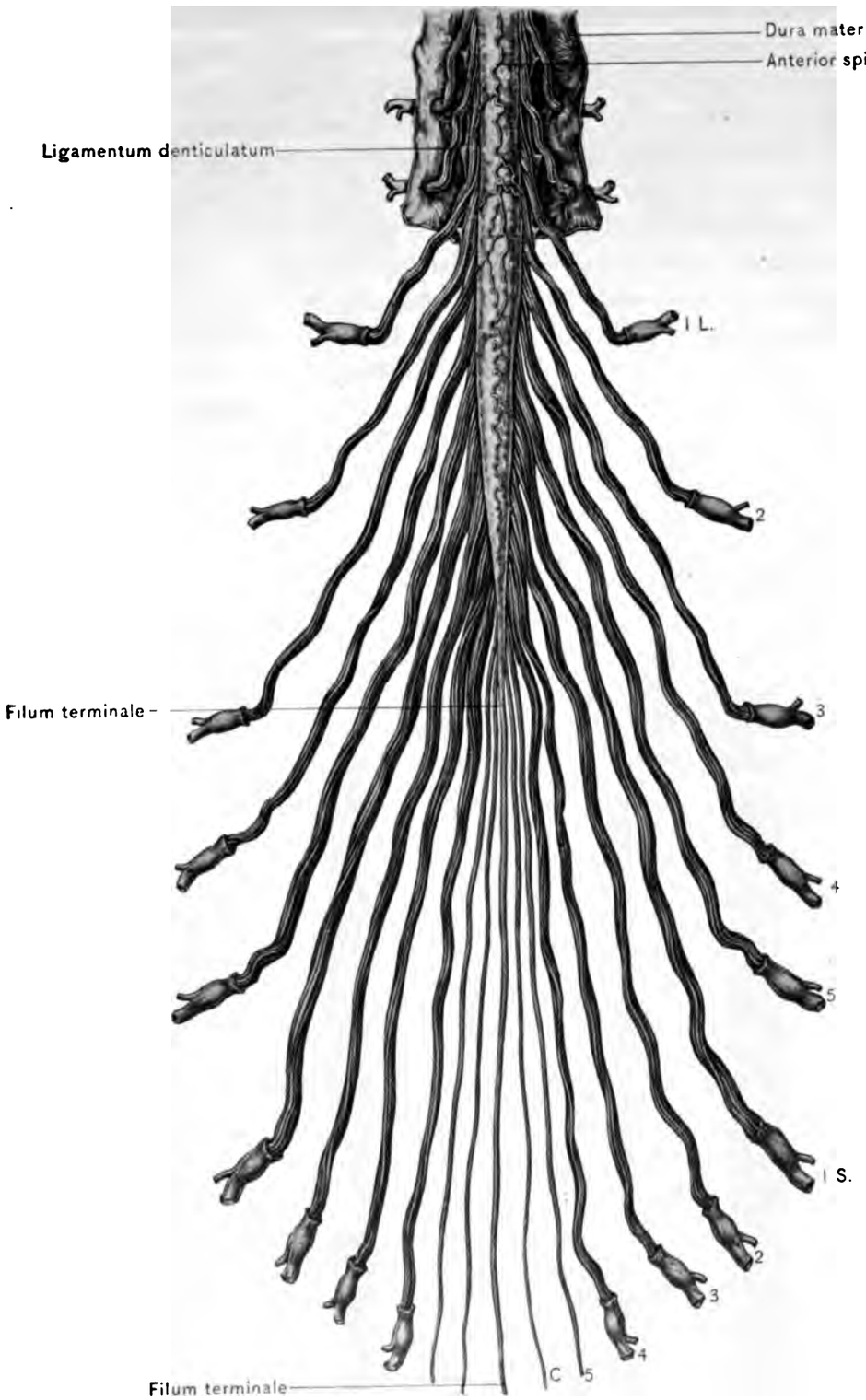
organ. Pressure exerted upon the swelling of a spina bifida will at times cause slight bulging of the anterior fontanel. As the subarachnoid space communicates with the ventricles of the brain, opening a spina bifida may drain the cerebro-spinal fluid from the brain and result in fatal convulsions.

DISSECTION.—Incise the arachnoid and reflect it from the underlying pia mater. This will open the subarachnoid space, which has just been inflated. It will be seen that the arachnoid is attached to the pia mater by numerous trabeculæ of subarachnoid tissue, and by three incomplete septa,—a posterior and two lateral,—which not only attach the two membranes to each other, but at the same time divide the subarachnoid space into compartments. The posterior septum is placed opposite the posterior median fissure of the cord, and is less marked in the cervical region. It carries blood-vessels to the cord. The two lateral septa are formed by the ligamenta denticulata.

The pia mater.—The pia mater is a thin, delicate, vascular membrane which is continuous with the pia mater of the brain. It is closely adherent to the cord, and sends vertical partitions, or septa, into the anterior and posterior median fissures. Along the anterior median line of the cord the pia is thickened into a glistening band—the *linea splendens*. The pia mater is supported at the sides by two lateral bands—the ligamenta denticulata. Each *ligamentum denticulatum* is a fibrous band which is attached to the median lateral aspect of the pia from the level of the foramen magnum to the level of the first lumbar vertebra. The attachment of each ligament to the pia is found midway between the anterior and posterior nerve roots. From this attachment each ligament extends outward, and is attached to the dura mater by numerous denticulations, or strips, which pass outward in the interval between the anterior and posterior roots of the spinal nerves. These processes push the arachnoid before them. It will be seen from this arrangement that the ligamenta denticulata divide the subarachnoid space into two compartments, in the anterior of which the anterior roots of the spinal nerves are found, and in the posterior the posterior roots of the nerves. The posterior compartment is again subdivided by a third or posterior septum, already mentioned in connection with the subarachnoid space. The ligamenta denticulata swing the cord in the center of the dural sac. From the conus medullaris the pia mater is continued downward as a slender thread, the *filum terminale*, as far as the base of the coccyx, to the periosteum of which it is attached. The filum terminale contains very little nervous matter, and is distinguished from the nerves of the cauda equina by its glistening white appearance.

The anterior and posterior roots of the spinal nerves emerge from the antero-lateral and postero-lateral aspects of the cord, and form a double row on each side of it. The anterior roots arise from the anterior horns of the gray matter and con-

PLATE CX'


Dura mater
Anterior spinal a.
Ligamentum denticulatum
I L.
2
Filum terminale
3
4
5
I S.
2
3
4
C
5
Filum terminale

tain motor fibers; the posterior are sensory fibers, and arise from the posterior horns. The fibers of the anterior roots emerge in several bundles which are not placed in a single line; whereas the posterior roots are larger, and their fibers also emerge in several bundles, which form a single row at the postero-lateral fissure. These roots of the nerves pass along for a varying distance within the dural sheath of the cord, which intra-dural portion of their course is called intra-thecal. The *intra-thecal course* of the nerves is shorter above and longer below, as the upper spinal nerves pass transversely outward and the lower pass downward with increasing degrees of obliquity. As the cord terminates opposite the second lumbar vertebra, the lumbar and sacral nerves and the coccygeal nerve have a longer intra-thecal course than those above. If the lumbar and sacral nerves are cut out with the cord, a condition similar in appearance to the under surface of a horse's tail will be seen, and hence the designation *cauda equina* given to these nerves. As the spinal cord is shorter than the spinal canal, and as the nerves emerge from the whole length of this canal, each succeeding nerve, growing longer in its intra-thecal course, is held to the cord by its arachnoid investment until opposite its foramen of exit, when it also passes horizontally outward like the first spinal nerve. The nerves of the cauda equina, however, pass down the canal parallel to one another and enter the intervertebral foramina a little obliquely. The two roots unite within the intervertebral foramen to form a single nerve. A short distance above the point of junction the posterior roots contain swellings or ganglia. These ganglia contain the trophic centers for the sensory fibers of the spinal nerves.

The **Fissures of the Spinal Cord** are an anterior median, a posterior median, two antero-lateral, and two postero-lateral.

The **anterior median** is a true fissure, and has a depth equal to one-third of the antero-posterior diameter of the cord. It extends the entire length of the cord, and is the continuation of the corresponding fissure of the medulla oblongata, at the lower part of which it is considerably interrupted by the decussation of the pyramids. The pia mater dips into it as a double fold.

The **posterior median fissure** is not an open and true fissure, but a narrow cleft, lodging only a process of the pia mater, which dips into it and forms a septum. It is continuous with the corresponding fissure of the medulla oblongata, and

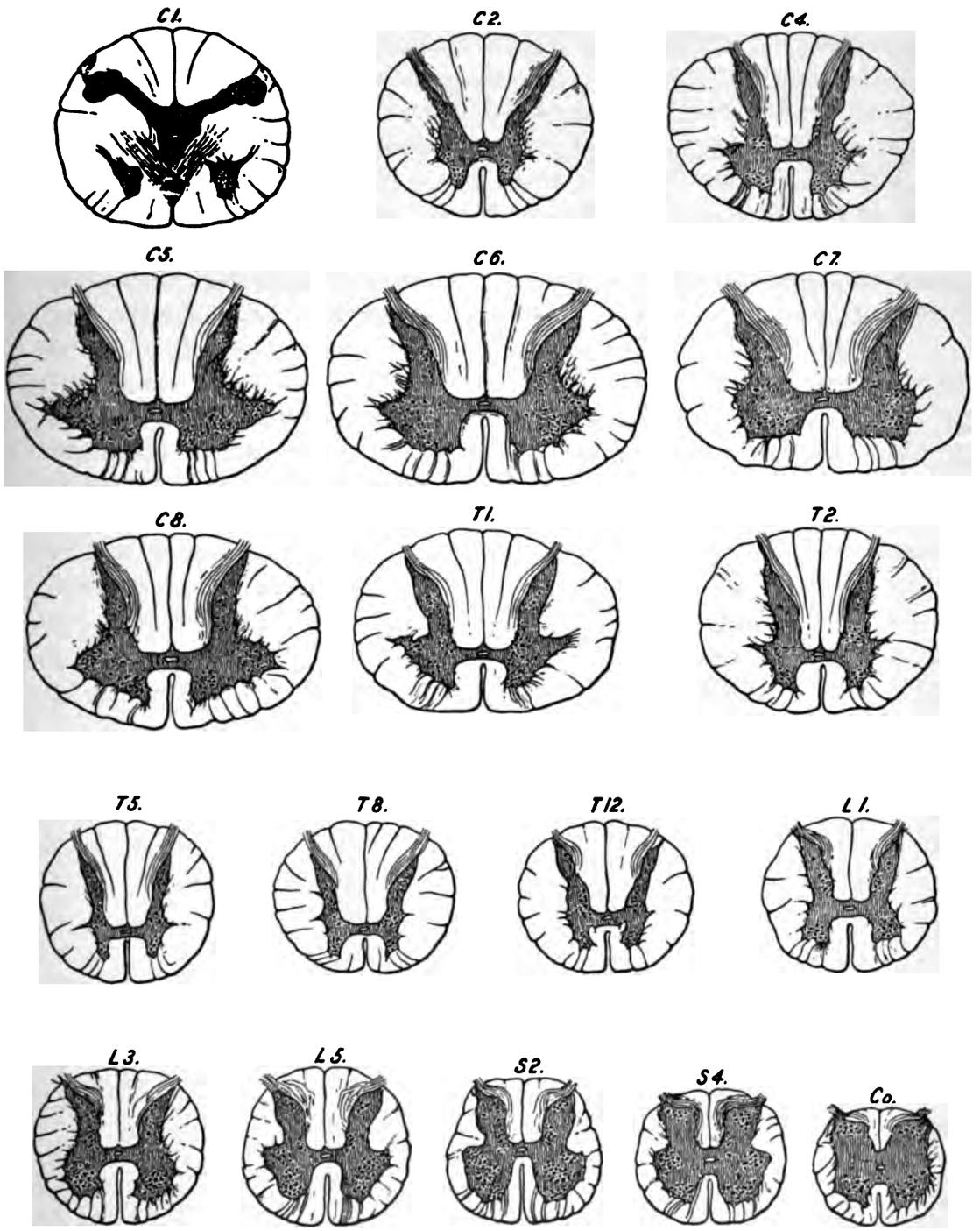
ever, well marked, the fibers of the posterior roots of the nerves emerging from it in a single row of bundles. It is deepest in the cervical region, and is continuous with the dorso-lateral fissure of the medulla.

Formerly, the spinal cord was divided into three columns,—an anterior, a lateral, and a posterior,—which are marked out by the anterior median, antero-lateral, postero-lateral, and posterior median fissures; but as the antero-lateral fissure is incomplete, the cord is now divided into an antero-lateral and a posterior column.

In the spinal cord the arrangement of white and gray matter is the reverse of that in the brain, its white matter being upon the outside and the gray matter inside, though the gray matter comes to the surface at the bottom of the posterior median and postero-lateral fissures.

The **Macroscopic Structure of the Spinal Cord** in a transverse section is very simple. If cut across, it is found to consist of white matter enveloping an H-shaped central mass of gray matter. The arms of the H are in the form of crescents whose convexities are adjacent and united by a band of gray matter called the **gray commissure,** a misnomer, however, as the commissure is chiefly composed of decussating, and not commissural, fibers. The anterior ends of these crescents are expanded and the posterior extremities taper, so that the crescents have been described as comma-shaped. The portion of the crescent in front of the commissure is called the **anterior horn,** while that part behind it is termed the **posterior horn.** The end of the anterior horn is rounded and expanded; the posterior horn is long and tapering, gives origin to the posterior roots of the spinal nerves, and closely approaches the surface of the cord. The anterior horns do not reach the surface, but send out numerous nerve fibers to form the anterior roots of the spinal nerves. In the center of the gray commissure is the **central canal** of the cord, which is lined by epithelium and is continuous, above, with the fourth ventricle of the brain. It appears, upon section of the cord, as a very small spot. This canal is the remains of the original neural canal of the embryo, from the walls of which the spinal cord is formed. In front of the gray commissure, between it and the bottom of the anterior median fissure, is a layer of white substance called the **white commissure.** For further details, both as to arrangement and changes in size and form of the cord on section at different levels, the reader is referred to

PLATE CXVI.



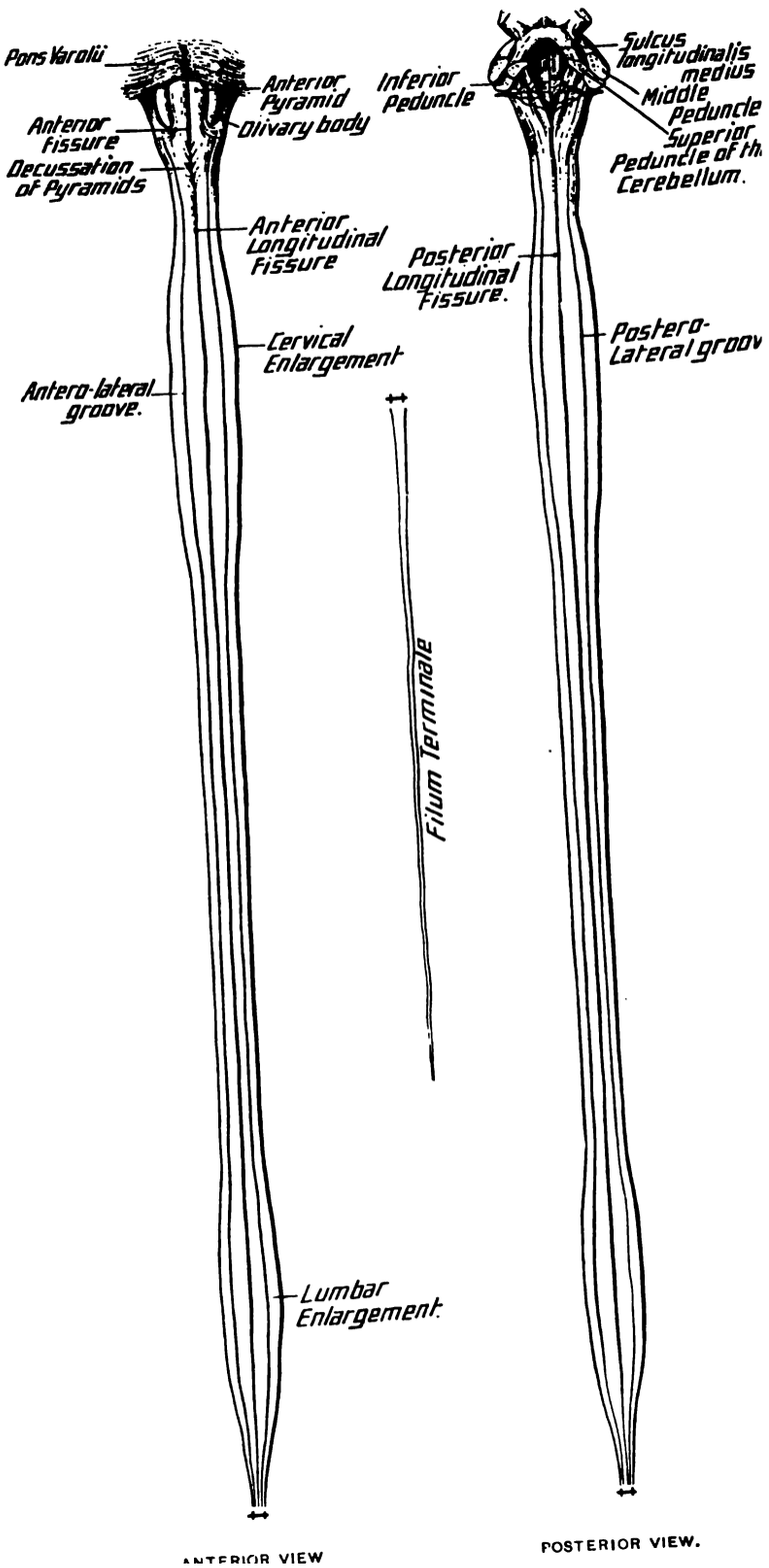
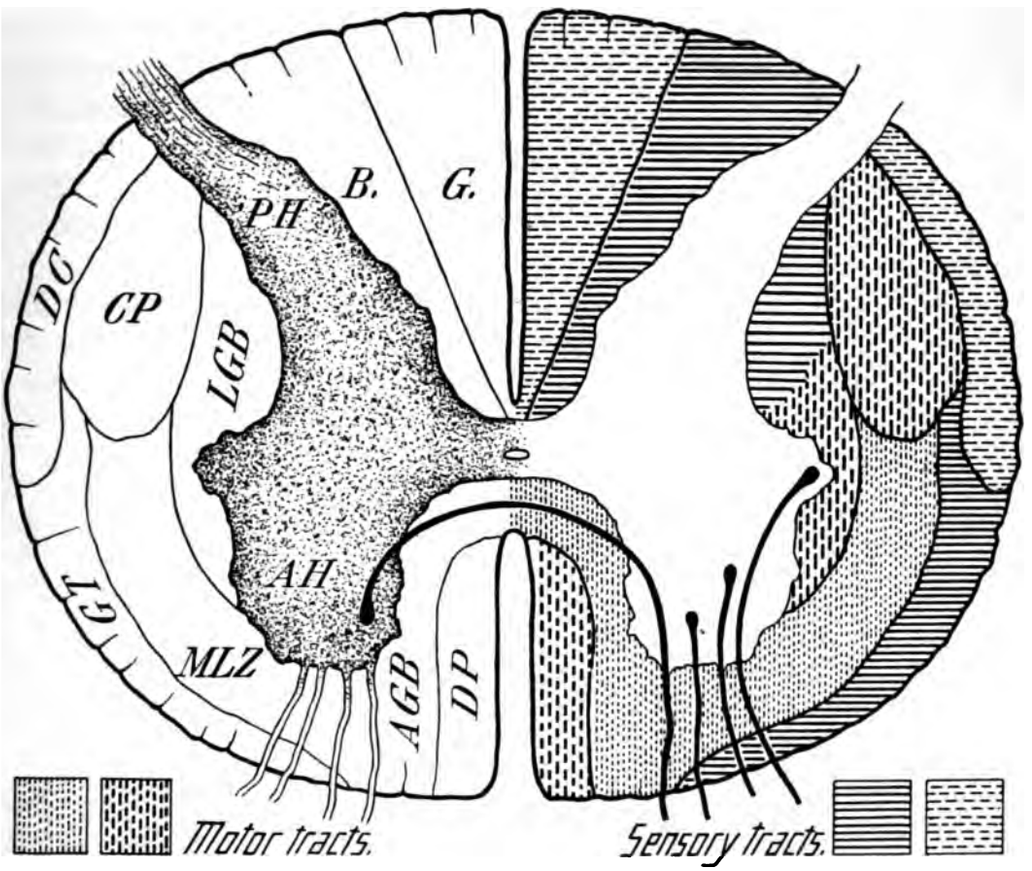
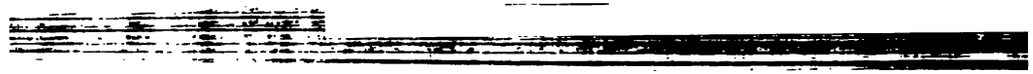

Pons Varolii
Anterior Pyramid
Olivary body
Anterior fissure
Decussation of Pyramids
Anterior Longitudinal Fissure
Cervical Enlargement
Antero-lateral groove.
Lumbar Enlargement
Filum Terminale
Inferior Peduncle
Sulcus longitudinalis medius
Middle Peduncle
Superior Peduncle of th Cerebellum.
Posterior Longitudinal Fissure.
Postero-Lateral groov
ANTERIOR VIEW
POSTERIOR VIEW.

PLATE CXVIII.



G. Column of Goll. *B.* Column of Burdach. *P.H.* Posterior Horn. *A.H.* Anterior Horn. *D.C.* Direct Cerebellar Tract. *C.P.* Crossed Pyramidal Tract. *L.G.B.* Lateral Ground Bundle. *G.T.* Gowers' Tract. *M.L.Z.* Mixed Lateral Zone. *A.G.B.* Anterior Ground Bundle. *D.P.* Direct Pyramidal Tract.



spinal cord have a definite arrangement. Each half of the spinal cord is divided into an antero-lateral and a posterior tract by the postero-lateral fissure.

The **antero-lateral tract** contains the direct pyramidal, crossed pyramidal, and direct cerebellar tracts, Gowers' tract, and the antero-lateral ground bundle.

That portion of the antero-lateral tract which is in relation with the anterior median fissure is the **anterior** or **direct pyramidal tract (column of Turck).** It is the continuation of the anterior pyramid of the medulla, and contains those fibers which do not decussate in the medulla, though in all probability they do so in the cord by passing through the anterior commissure and thence to the crossed pyramidal tract of the opposite side. It tapers as it passes downward, and terminates in the middle of the thoracic region. It contains descending fibers—*i. e.*, fibers in which nerve impulses descend.

The **crossed or lateral pyramidal tract** contains the greater number of the fibers of the anterior pyramid of the medulla—those which decussate. It passes downward into the posterior portion of the antero-lateral tract in front of and to the outer side of the posterior cornu. It contains descending fibers, and extends the whole length of the cord.

The **direct cerebellar tract** lies between the lateral pyramidal tract and the surface of the cord, and does not extend further forward than that tract. It begins at the level of the root of the first lumbar nerve, ascends to form part of the restiform body of the medulla, contains ascending fibers, and increases in size as it ascends.

Gowers' tract, or the antero-lateral ascending tract, is a band of fibers on the surface of the cord in front of the direct cerebellar tract. It contains ascending fibers which enter the outer side of the tract of the fillet.

The **antero-lateral ground bundle** comprises the remainder of the antero-lateral tract. This has been subdivided into the anterior ground bundle, the mixed lateral zone, and the lateral ground bundle.

The *anterior ground bundle* is separated from the remainder of the antero-lateral ground bundle by the anterior roots of the spinal nerves and the anterior cornu. This division is hardly warrantable, as it contains fibers similar to those of the mixed lateral zone. Its fibers connect the cells of the anterior cornu.

The *mixed lateral zone* is the backward continuation of the anterior ground bundle, and is limited behind by the crossed pyramidal tract. It contains both ascending and descending fibers which are connected with the cells of the anterior

rior portion contains fibers which are connected with the anterior cornu, and its posterior portion has fibers connected with the posterior cornu.

The **posterior tract** of the white matter of the cord is divided into two portions—the columns of Goll and Burdach. These are separated by a septum, and on the surface of the cord by a furrow.

The **column of Goll, or postero-internal tract,** is in relation with the posterior median fissure. It contains ascending fibers which are derived from the posterior roots of the nerves and others which connect the cells of the posterior cornu. Above, it is continuous with the posterior pyramid of the medulla.

The **column of Burdach, or postero-external tract,** lies between the column of Goll and the posterior cornu. It contains ascending fibers which are derived from the posterior roots of the nerves and others which are associated with the cells of the posterior cornu. Like the column of Goll, it is continuous above with the posterior pyramid of the medulla.

The **boundary zone of Lissauer** is composed of the most external fibers of the posterior roots of the spinal nerves; these fibers ascending in that column or zone to enter the posterior cornu.

The microscopic structure of the cord is not within the scope of this work, and is therefore not given.

The **Arteries of the Spinal Cord** are the anterior spinal artery and the posterior and lateral spinal arteries which form upon the cord an anterior median and four postero-lateral arteries.

The **anterior spinal artery** is a small branch which arises from the vertebral artery near its termination. It joins its fellow of the opposite side in front of the medulla oblongata, and forms a single median vessel which descends in front of the cord to its termination and for some distance on the filum terminale. It is joined on either side by branches from the lateral spinal arteries. This median vessel is lodged under the pia mater in the anterior median fissure, and supplies the cord and the cauda equina.

The **posterior spinal arteries** are derived from the vertebral artery at the side of the medulla; each artery passes to the side of the cord and divides into an anterior and a posterior branch, one branch running in front of the posterior roots of the spinal nerves and the other behind them. These arteries continue down the postero-lateral aspect of the cord to its termination. They are joined by the lateral spinal arteries and supply the adjacent cord, membranes, and cauda

arteries. They enter the spinal canal through the intervertebral foramina, and divide into two branches—one of which goes to the back of the bodies of the vertebræ and the other reaches the cord upon the posterior root of a spinal nerve. Some of the latter branches join the anterior median artery while the others either terminate in the nerve root or join the postero-lateral arteries of the cord. They supply the cord, its membranes, and the vertebræ.

The **Veins of the Spinal Canal and Spinal Cord** are the dorsi-spinal, the meningo-rachidian, the venæ basis vertebræ, and the veins of the cord itself. All the veins of the spinal canal and spinal cord are devoid of valves.

The **meningo-rachidian veins** have been described.

The **veins of the spinal cord** (medulli-spinal) form a plexus over the surface of the cord within the pia mater, and emerge chiefly from the anterior and posterior median fissures. Branches from the plexus pass outward upon the nerve roots and communicate with the meningo-rachidian veins which in the upper part of the spinal canal empty into the vertebral and the inferior cerebellar veins or into the inferior petrosal sinuses, and in the lower part of the canal into the intercostal and lumbar veins.

The **Motor, Sensory, and Reflex Areas** of the body governed by the spinal cord at different levels are approximately shown in the accompanying table from Gowers. While it is not my object to go into any details as to the structure or function of the spinal cord, it is perhaps well to say a few words upon the subject. Thus, while most of the motor fibers cross at the decussation of the pyramids in the medulla, the sensory fibers cross in the cord throughout its entire length. This difference in the motor and sensory decussation is only anatomic, for from the functional standpoint they cross over upon the same principle—*i. e.*, practically upon their entrance into the cord: the motor fibers, with the exception of those of the direct pyramidal tract, entering above *en masse*, soon decussate in a body; and the sensory fibers, entering at different levels, cross over soon after their entrance, thus decussating separately all along the cord.

Reflex Action is a fanciful designation to indicate the centripetal impulse along a sensory nerve to the nerve center (gray matter) and the resulting centrifugal (return, reflected) impulse along a motor nerve. Thus, if a corn be

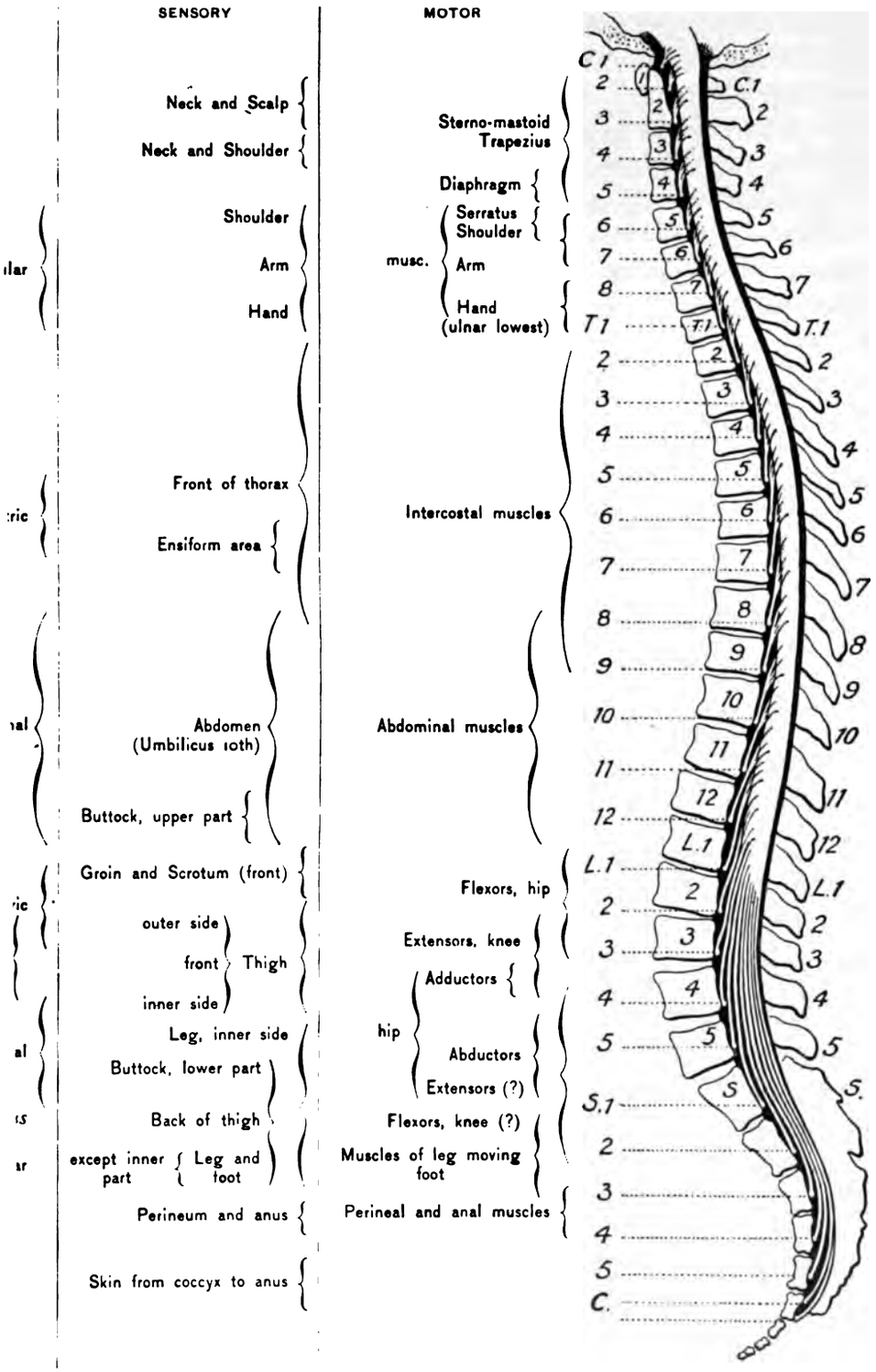
termed a segment, though, of course, there is no anatomic separation of the cord into these segments.

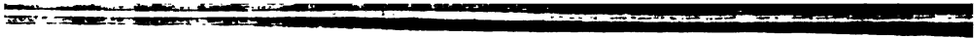
Pathologic processes may involve one of these segments; such a lesion is called a focal lesion: a tumor would be an example of this. When one or more longitudinal tracts or systems of fibers are diseased the condition is designated a systemic disease; of this, locomotor ataxia is an example.

Disease of the Spinal Cord may affect its entire transverse area, or certain portions of it, in varying lengths; or it may begin at any level, and thence extend upward or downward; in that event being designated ascending or descending.

Inflammation of the anterior horns of the spinal cord is a disease quite often seen in infants, and frequently overlooked; its most constant symptom is paralysis of a group of muscles of the extremities; because of an infant's inability to walk, this symptom is not readily detected.

The **signs of lesions** of the cord depend upon the area of gray matter or column of nerve fibers involved. Whether the symptoms be those of irritation or of paralysis depends upon the kind and degree of the pathologic process. An active congestion of the cord may cause symptoms of irritation, such as tingling, fibrillary twitching, and pains; while enough turgescence and exudate to cause marked compression will result in numbness and motor paralysis. Passive congestions produce their most marked symptoms in the morning, because of the gravitation of venous blood to the cord during recumbency upon the back. All active inflammatory diseases of the spinal cord are aggravated by exercise, for the double reason that movements of the spinal column and functional activity of the cord increase the blood supply. Again, an intra-spinal tumor will, as it begins to encroach upon the cord, at first produce signs of irritation, and compression symptoms (paralysis or loss of function) will manifest themselves as the encroachment increases. Any disease involving the integrity of the entire transverse diameter of the cord will cause complete motor and sensory paralysis of the areas supplied by the part of the cord at and below the site of the disease. If the lesion affect only one lateral half of the cord, there will be motor disturbance on the same side of the body below the lesion and sensory disturbance upon the other side, which is accounted for by the different modes of decussation of the motor and


SENSORY
MOTOR
Neck and Scalp
Neck and Shoulder
Shoulder
Arm
Hand
Front of thorax
Ensiform area
Abdomen (Umbilicus 10th)
Buttock, upper part
Groin and Scrotum (front)
outer side
front
inner side
Thigh
Leg, inner side
Buttock, lower part
Back of thigh
except inner part
Leg and foot
Perineum and anus
Skin from coccyx to anus
Sterno-mastoid
Trapezius
Diaphragm
musc.
Serratus
Shoulder
Arm
Hand
(ulnar lowest)
Intercostal muscles
Abdominal muscles
Flexors, hip
Extensors, knee
hip
Adductors
Abductors
Extensors (?)
Flexors, knee (?)
Muscles of leg moving foot
Perineal and anal muscles
C.1
T.1
L.1
S.1
S.
C.



Protection to the Spinal Cord is afforded by a number of safeguards; these are the following: The free mobility of the spinal column as a whole; the slight amount of movement between any two vertebræ; the elastic intervertebral discs which break up force and shock applied to the spinal column; the comparatively large size of the spinal canal in the cervical and lumbar regions where the mobility is most marked; the curves of the spinal column which lessen shock and force; suspension of the cord in the spinal canal by the ligamenta denticulata; the spinal dura mater which is so tough that the cord may be ruptured without laceration of the dura; and the cerebro-spinal fluid.

Injuries.—The spinal cord is most likely to be injured at the atlo-axoid joint, at the junction of the cervical and thoracic regions, and near the junction of the thoracic and lumbar regions of the spinal column. At the atlo-axoid joint injury is more likely because of the mobility of that part of the spinal column and the fact that in that location the cord nearly fills the canal. At the junction of the cervical and thoracic regions injury is common, because there the freely movable cervical vertebræ join the thoracic vertebræ, between which there is very little motion. Injury of the cord in the neighborhood of the last thoracic and first lumbar vertebra is frequent, because in that location the almost rigid thoracic region joins the freely movable lumbar region of the spinal column, and because the length of that part of the spinal column above permits great leverage.

Fractures of the Spinal Column are usually produced by indirect violence, as in overflexion or overextension of the spinal column, as when a person falls upon the head or buttocks, or is stooping and a heavy weight falls upon the shoulders, one of the supra-spinous ligaments ruptures and the posterior arches of one or two of the vertebræ near the point of rupture are fractured. Usually the fragments so completely crush the cord that operation to remove or elevate them does not improve the condition.

Fractures of the spinal column **above the fifth cervical vertebra**—that is, above the origins of the phrenic nerves—are almost invariably fatal because of paralysis of the diaphragm.

Fractures of the **fifth, sixth, and seventh cervical vertebræ** cause paralysis of the intercostal and abdominal muscles; while death may not occur at an early date, respiration can only be maintained by the action of the diaphragm, and this finally fails through lack of assistance from the paralyzed muscles.

In fractures of the **lower part of the thoracic region** the prognosis is not so unfavorable.

Tumors within the spinal canal, arising from the membranes of the cord or the wall of the canal, as they increase in size, gradually [illegible] upon the spinal cord. At first [illegible]

esthesia, and later, through pressure, cause complete paralysis and anesthesia of the parts supplied by the portion of the cord below the site of the tumor. There may be some disturbance of micturition or defecation, but after a time the centers in the spinal cord more or less imperfectly control these latter functions. Irritation of the cord just above the tumor causes a girdle sensation, produced by the nerves which arise from that portion of the cord. In the early part of the progress of the growth but one side of the cord is usually affected; later, the whole cord is involved, and the symptoms are present in both sides of the body.

Marked pressure upon or any other **total transverse lesion** of the spinal cord, as in fractures of the spinal column, irritates the nerves which arise immediately above the lesion, and causes pain in the area supplied by these nerves. Therefore girdle pains may be of value in locating the lesion. The upper thoracic nerves supply corresponding intercostal spaces; the sixth and seventh thoracic nerves, the region of the ensiform cartilage; the tenth thoracic, the region of the umbilicus.

Degeneration in the Motor Tracts of the cord descends, and in the sensory tracts ascends. This is due to the fact that the trophic centers of the motor tracts are in the gray matter of the brain, whereas those of the sensory tracts are in the ganglia upon the posterior roots of the spinal nerves. In the crossed pyramidal tracts we find three sets of fibers—motor, vasomotor, and fibers which carry impulses for inhibition of reflex action. The vasomotor and inhibitory fibers pass to the motor cells of the anterior horns. When the crossed pyramidal tract degenerates, these inhibitory and vasomotor fibers are included, and dilatation of the blood-vessels and increased reflexes result.

Voluntary motor impulses arise in the motor region of the cerebral cortex near the fissure of Rolando. They then pass through fibers of the corona radiata, the internal capsule, partly through the corpus striatum, through the crusta of the crura cerebri, the pons, and the anterior pyramids of the medulla. Here most of the fibers cross to enter the crossed pyramidal tract of the opposite side of the spinal cord, and the fibers which do not cross continue downward as the direct pyramidal tract and cross through the anterior or white commissure to the anterior horn of the opposite side; therefore all impulses eventually pass to the opposite side. They pass to the motor cells in the anterior horns of the gray matter, and, through the motor nerves which arise from these cells, pass to the muscles.

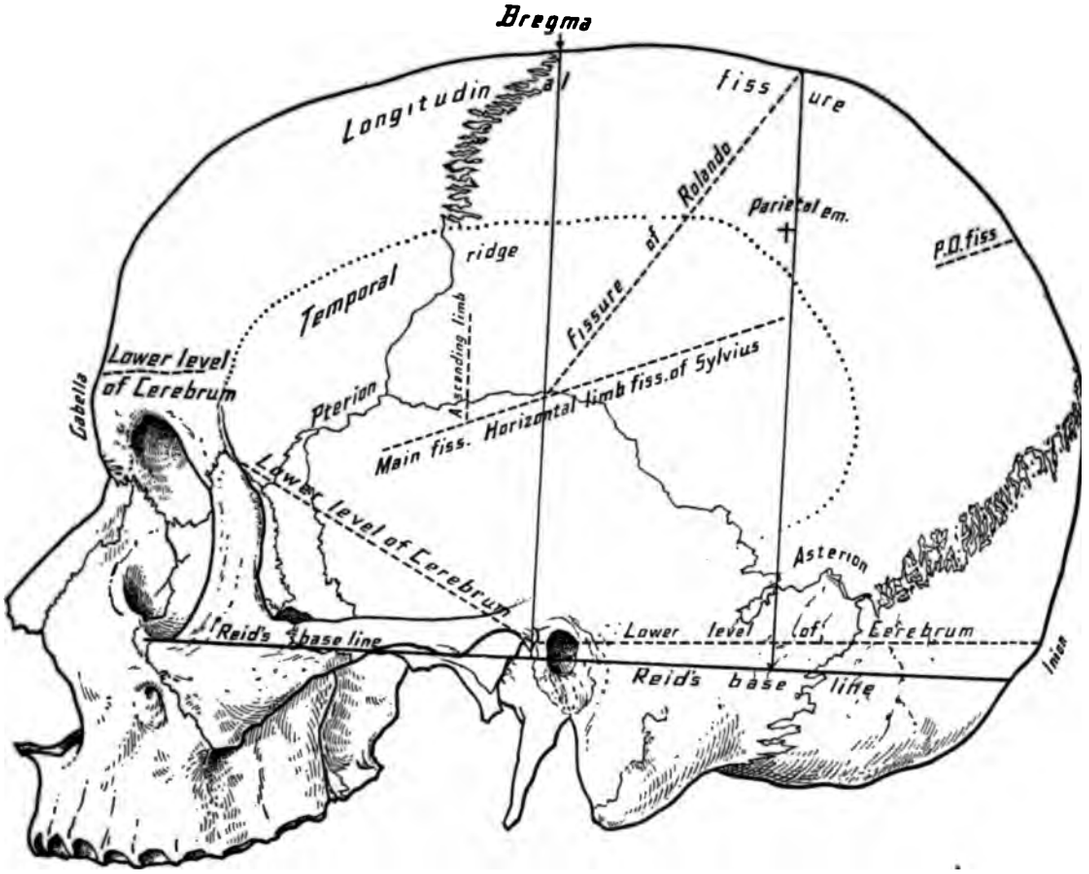
A **sensory impulse** arises in the sensory end organs in the skin and passes along the sensory nerves directly to the cells in the posterior horns, or indirectly through the column of Burdach and boundary zone of Lissauer. The fibers pass from the cells in the posterior horn to the postero-internal column of the

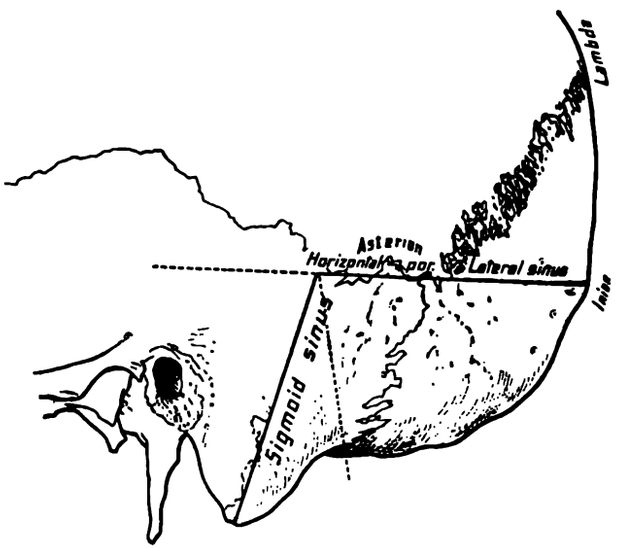
of the scalp are movable if above the cranial aponeurosis; when below it they are immovable.

The **arteries** of the scalp are the frontal, which ascends near the median line; the supra-orbital, which is found above the supra-orbital notch and for some distance up the forehead; the anterior branch of the temporal artery (often very tortuous), found about one and one-quarter inches behind the external angular process of the frontal bone; the posterior branch of the temporal, which runs above and in front of the ear; the posterior auricular, above and behind the ear; and the occipital, distinguishable about midway between the mastoid process and the external occipital protuberance.

In examining the head as a whole, it will be noticed that the two sides are not symmetric—one side almost always having larger dimensions than the other. Although the general conformation of the skull cap is a fair index of its contents, it does not follow that every minute change in form of the brain has its effect upon the skull, as is claimed by many phrenologists.

The **cranial bones** are the frontal, two parietal, two temporal, the occipital, the sphenoid, and the ethmoid. In the adult they are immovably connected with one another, the lines of their junctions being termed sutures. In infancy the frontal bone consists of two portions; these coalesce very early in life, the line of union being the **frontal suture.** The two parietal bones are joined by the **sagittal suture.** The course of the two sutures, the frontal and sagittal, corresponds to a line drawn from the root of the nose, directly backward over the median line of the vault of the skull, to the external occipital protuberance. In this line, within the skull, are the superior longitudinal sinus and the longitudinal fissure of the cerebrum. The parietal bones are joined to the frontal bone by the **coronal suture,** and to the occipital bone by the **lambdoid suture.** About one inch anterior to the center of a vertical line drawn directly over the skull from one external auditory meatus to the other, and at the junction of the coronal with the sagittal suture, is the **bregma,** which is the situation of the anterior fontanel of the infant. The **coronal suture** corresponds to a line drawn from the bregma to the middle of the zygomatic arch. The **lambdoid suture** is represented by a line drawn from the


Bregma
Longitudinal fissure
Rolando
Parietal em.
P.O. fiss
Temporal ridge
Ascending limb
Fissure of
Lower level of Cerebrum
Gabella
Pterion
Main fiss. Horizontal limb fiss. of Sylvius
Lower level of Cerebrum
Asterion
Reid's base line
Lower level of Cerebrum
Reid's base line
Inion


Lambda
Asterion
Horizontal limb
Lateral sinus
Inion
Sigmoid sinus

the elevation above the root of the nose, and extend outward in a gentle curve, gradually becoming less prominent. The superciliary ridges mark the location of the sinuses of the frontal bone, but may vary greatly, generally because of the difference in size of the frontal sinuses. They are small in females and absent in children. Although the size of the ridge may be an indication of the size of the frontal sinus, yet this does not always hold good, as we may find a large ridge with but little development of the sinus; and vice versâ. Some of the Australian aborigines have very small sinuses, but large ridges, due to great thickness of the bone.

Above the superciliary ridges are found the **frontal eminences.** They are slightly convex elevations which mark the original centers of ossification in the two frontal bones. Their prominence is generally considered as an index of the amount of intellectual capacity of the individual. The increase in the development of the skull as a whole causes the frontal bones to become upright, and thus makes the frontal eminences more prominent.

Immediately behind the external ear is the **mastoid process** of the temporal bone. It is but rudimentary in infancy, and develops later in life. It extends downward for about an inch below the external auditory meatus, and projects forward slightly under it. The **digastric fossa** is internal to the mastoid process. The body of the process is honeycombed with air-cells, which are connected with the middle ear. At times these become so inflamed that trephining or incision is necessary to afford relief. The incision should be made in the hairless space behind the ear (Wilde's incision). A line connecting the tips of the two mastoid processes would pass through, or immediately under, the condyles of the occipital bone.

About half an inch above and three-quarters of an inch behind the posterior border of the mastoid process is the **asterion**—the junction of the lambdoid and squamous sutures.

The **external occipital protuberance** (**inion**) is distinctly felt in the median line at the posterior part of the head, at the junction of the skin of the neck with that of the head. It is the thickest part of the vault of the skull. From it the superior curved lines of the occipital bone extend laterally and give attachment to some of the muscles which support the head. The external occipital protuberance marks the position of the torcular Herophili, or the confluence of the superior longitudinal, two lateral, straight, and occipital sinuses. Above the superior curved lines the general contour of the skull can be readily seen, as the covering is composed of thin structures. Below these lines, however, the skull recedes to a considerable extent, the space being filled in with the

occipital bone, and the tumor caused by the protruding cranial contents is always in the median line.

The **parietal eminences** which mark the position of the centers of ossification in the parietal bones are readily distinguishable on the sides of the skull above the ears. They are much more marked in infancy, gradually becoming rounded and less prominent. Anterior to the parietal eminences, and running along the sides of the head, are the two **temporal ridges** which limit the temporal fossæ above and give attachment to the temporal fascia. They commence at the external angular process of the frontal bone and arch upward, backward, and then downward, to become lost on the posterior roots of the zygomatic process. The point where the coronal suture is crossed by the temporal ridge is known as the **stephanion.** It is about one and one-quarter inches above the pterion.

The **middle meningeal artery** passes upward on the anterior inferior angle of the parietal bone, and is found by trephining an inch and a half behind and about an inch above the external angular process.

The **course of the superior longitudinal sinus** is indicated by a line drawn over the median line of the top of the head, or from the root of the nose to the external occipital protuberance.

The **course of the horizontal portion of the lateral sinus** is shown by the posterior part of a line drawn from the external occipital protuberance to a point one inch above the external auditory meatus. The sinus turns downward and becomes the sigmoid sinus at the point where a vertical line drawn through the posterior border of the base of the mastoid process crosses the line for the horizontal portion.

The **course of the sigmoid sinus** is marked by a line drawn from the point of termination of the horizontal portion of the lateral sinus to the tip of the

thickened, brownish epidermis (keratosis senilis), particularly in persons much exposed to the weather. After middle life there is a tendency to dilatation of the superficial vessels, especially on the nose and cheeks.

The absorption of the alveolar processes and loss of the teeth cause the characteristic appearance of the mouth in old age; the lips being inverted, the red border becomes narrower, and when the mouth is closed the chin is drawn toward the nose.

The more or less characteristic changes produced by disease can not, of course, be described here; allusion may be made to the waxy hue of the skin in certain renal affections, the cyanosis in grave cardiac lesions, the hectic flush associated with pulmonary tuberculosis, and the "facies hippocratica." In the last named the sunken temples and cheeks; the pointed nose and chin; the dull, leaden hue; the few drops of perspiration, and the cold, clammy skin portend the near approach of death.

The **supra-orbital arches** are readily recognized as the dividing line between the forehead and the face. They are strong arches which form the upper boundary of the circumference of the orbit. They are covered by the eyebrows. Internally they end in the internal angular processes of the frontal bone, which articulate with the lacrymal bone and the nasal process of the superior maxilla. Between the two internal angular processes, at the fronto-nasal suture, a meningocele or an encephalocele sometimes appears. Externally, the supra-orbital arches terminate in the external angular processes, which articulate with the malar bone. Immediately below the supra-orbital arches are the eyes. They and their lids present points of interest. In size the eyes do not vary much in different individuals, the apparent difference being due to the variations in the length of the palpebral fissure, which thus permits a larger or smaller portion of the ocular surface to come into view. The **palpebral fissure** is the aperture between the edges of the two lids, and extends from the inner to the outer canthus. The fissure is not, as a rule, exactly horizontal, the outer canthus being generally a little higher than the inner.

By everting the eyelids, the **tarsal cartilage** may be felt as a thickened portion of the lid. The vertical arrangement of the Meibomian glands in the

The **puncta lachrymalia** are readily discernible near the inner canthus, the lower being the larger and more external. The introduction of a probe into the lacrymal canaliculus should be preceded by drawing the lid outward, thus straightening the canal.

The **tendo oculi** can be felt after drawing the eyelids outward, or forcibly closing the eye. Immediately behind this is the **lacrymal sac.** If a knife were pushed backward just below the tendo oculi it would enter the sac, with the angular artery and vein on the inner side of the puncture. A probe passing through this opening into the sac, and then downward, slightly outward, and backward, would enter the nasal duct and appear in the inferior meatus of the nose. Tension upon the tendon, as in closure of the eyelids, compresses the sac, with which it is closely connected, thus emptying the sac and forcing the tears which have collected at the inner angle of the eye down the nasal duct.

The **nasal duct** extends from the inner angle of the eye to the inferior nasal meatus, just under the inferior turbinated bone. It is about three-quarters of an inch in length, and constricted in its middle. The lower opening in the nasal mucous membrane is a slit, but there is quite a large opening in the dry bone. When the lower end of the duct lies in the lateral wall of the meatus instead of in its roof, greater difficulty is experienced in passing a probe into the duct.

The lower border of the orbit (**infra-orbital margin**) lies immediately below the eyeball and is formed by the superior maxillary and malar bones. It can be readily felt throughout its entire extent.

The **glabella** is a flat, triangular eminence situated between the two internal extremities of the superciliary ridges. Immediately below the apex of the glabella is found the prominence of the nose formed by the nasal bones.

The form of the nose and much of the general expression of the face are due to the size and form of the nasal bones. The difference in these bones accounts for the variations we find in the various races. In the Mongolian and Ethiopian the nasal bones are flat and broad at their base, and thus form the flat nose which is so characteristic of those races. In the Caucasian race, however, the nasal bones are narrow and elongated as well as prominent at the bridge. The nose is rigid at its root and base as far as its middle, beyond which it is cartilaginous and flexible. The intimate adherence of the skin to the nasal cartilages, which are attached to the lower ends of the nasal bones, makes furuncles or erysipelas in this region exceedingly painful, because of the lack of cutaneous elasticity.

The lower end of the nose is open and divided into the two **anterior nares** by the nasal septum and the *columna*. It should not be forgotten that the nose is attached lower than the floor of its cavity; so that it must be elevated when the

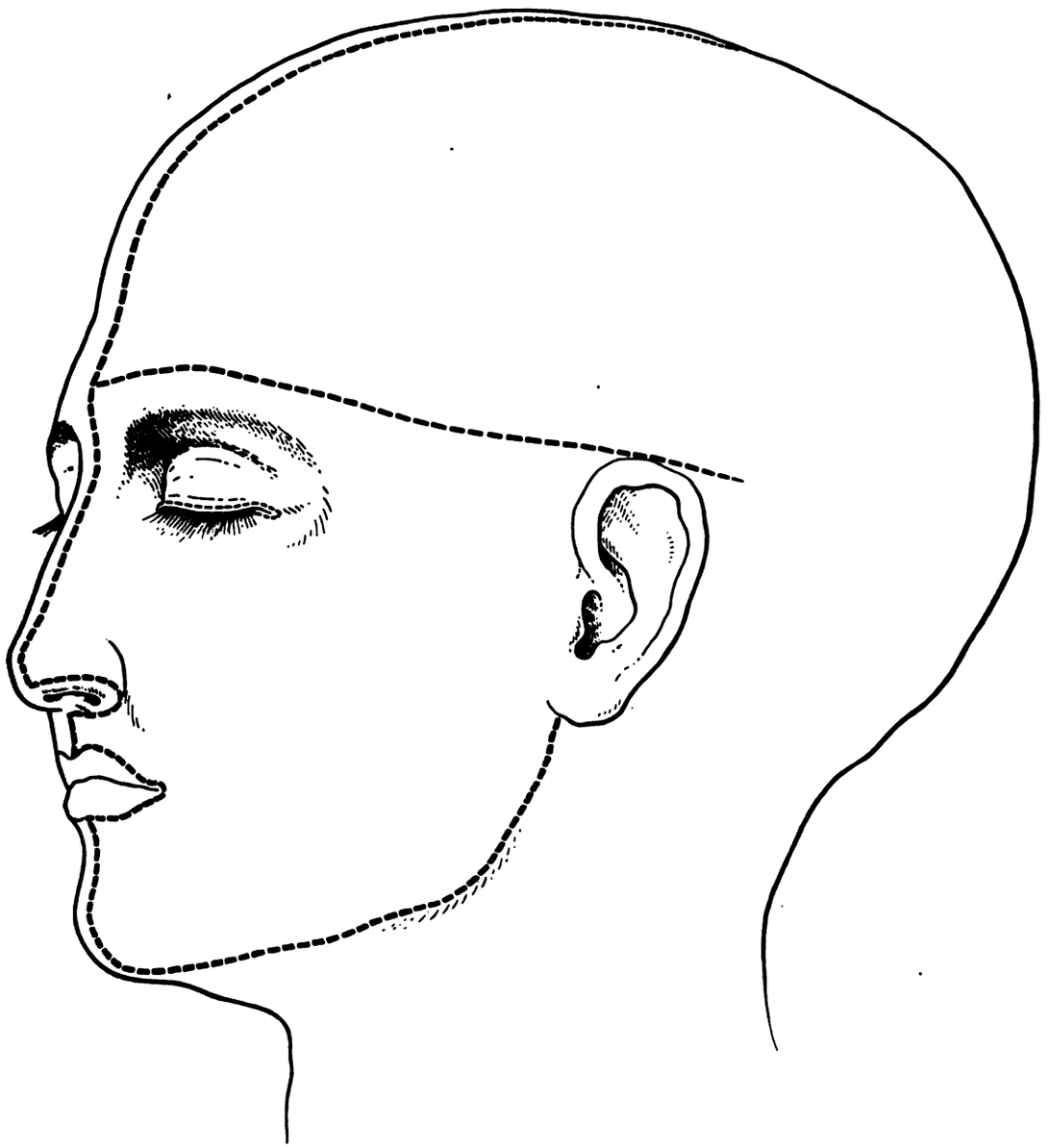
passes through the normal foramen, may be due to an accessory nerve, instead of to central disease or affections of the ganglia connected with the parent stem.

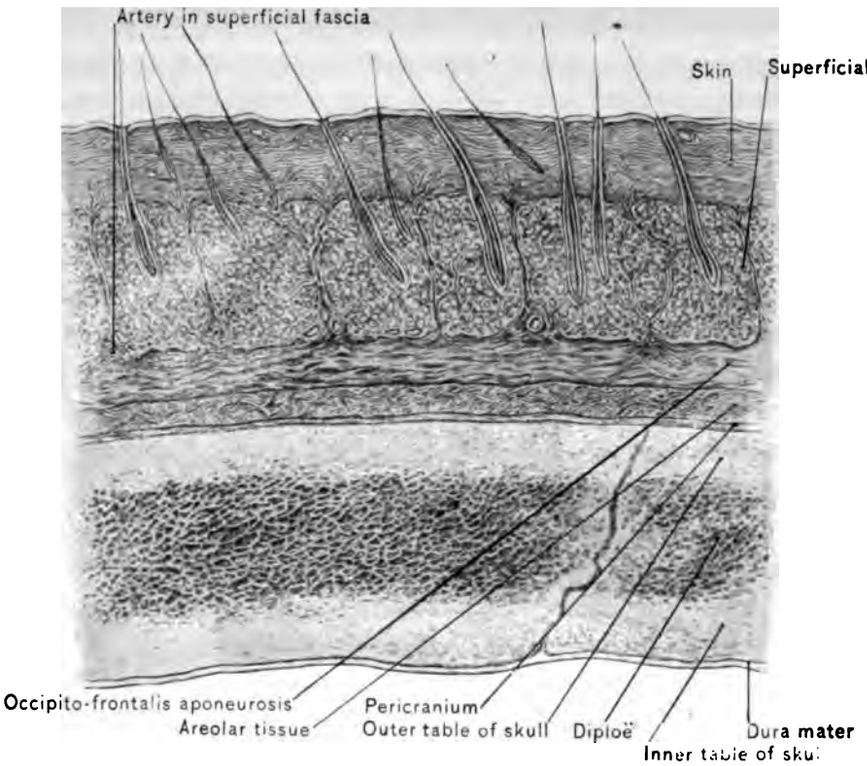
Continuing outward from the external angular process is the **zygomatic arch,** formed by the malar bone and the zygomatic process of the temporal bone. The anterior part of the arch is flat and broad, and forms the prominence of the cheek, or the "cheek bone." Posteriorly, the zygomatic arch terminates in front of, and just above, the external auditory meatus. On account of the attachment of the dense temporal fascia to the upper border of this arch, the lower border is more easily distinguished. The zygomatic arch forms a dividing line between two depressions. These are generally filled with fat in the healthy individual, and, therefore, are not markedly evident. As soon as a wasting disease begins to tax the organism, the fat above the zygoma is absorbed, and this bony arch becomes much more prominent; as the wasting progresses, the masseteric depression can be plainly seen, and, at the same time, the fat in front of the anterior margin of the masseter muscle and below the anterior half of the malar bone disappears, with resultant sinking of the cheeks.

The **arteries of the face** are the temporal, between the ear and zygoma, and the facial, on the body of the lower jaw just in front of the masseter muscle, at the angle of the mouth, and passing along the naso-labial fold and side of the nose to the inner angle of the eye. The facial vein runs straight across the face from the inner canthus of the eye to the anterior inferior angle of the masseter muscle at the lower border of the lower jaw. The anterior temporal and facial arteries are useful to the anesthetizer in studying the pulse, and also to the physician when the patient is sleeping.

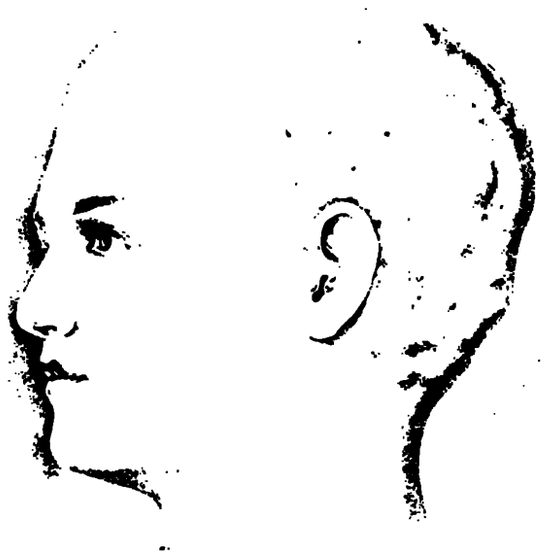
Expression is due to muscular traction upon the facial integument. In facial hemiplegia, when the muscles of the affected side have lost their power, expression is gone, and the wrinkles of the face disappear. The "expression of the eye" is due to wrinkling of the lids and the peri-ocular integument. The study of the relation between facial expression and the permanent markings of the face resulting therefrom, as an index to character and disposition, is still in its infancy. Note the proximity of the muscle centers of the face in the ascending frontal and parietal gyri to the speech center. The latter is at the tip of the operculum around the ascending arm of the Sylvian fissure, and at the lower part of the ascending gyri. Just above it is the lip center, followed by that of the face, fingers, hand, and arm, with that of the lower limb overtopping all. Is this not also the order in which these muscle groups are involved during increasing animation accompanying a dis-

PLATE CXXI.





LAYERS OF SCALP.



dimples, scowls, and puckerings, expressive of the condition of the mind in relation to the matter engaging it. The habitual recurrence of these emotional results leaves its impress by gradually undermining the elasticity of the skin involved and by contracting the affected muscles, producing upon the individual's face indications of his character which may be read by all who are competent.

The **external ear, or pinna,** is placed at the junction of the face, neck, and cranial vault. The general conformation and direction of the pinna, and its utility for the collection and partial condensation of sound, need only be mentioned. During inspection of the tympanic membrane and of the whole length of the external auditory canal, the direction of the latter concerns us practically. It is about an inch and a quarter long. When removing foreign bodies, which frequently lodge in this canal, it is important to note that it sags at its outer end, and can be straightened by pulling the pinna upward. The greatest diameter of the canal is vertical at the external end, and transverse at the internal. The upper and posterior portions of the tympanic membrane incline outward.

SCALP.

Dissection.—The dissection of the scalp should be made before that of the face and neck. The body should lie on its back, the head being well elevated by means of a large block placed under the nape of the neck. The head having been shaved, an incision should be carried from the root of the nose over the middle line of the vertex to the external occipital protuberance; and a second incision, at a right angle to the first, commencing at the nasal eminence, should extend on each side as far back as the ear. Beginning at the junction of the two incisions, reflect the skin backward and outward, forming two flaps. When

viz., skin, superficial fascia, attolens and attrahens aurem muscles, occipito-frontalis (epicranial) aponeurosis, areolar tissue, temporal fascia, the temporal muscle, and the periosteum. That which is usually spoken of as the scalp includes the skin, the superficial fascia, and the occipito-frontalis muscle and aponeurosis; these three layers are closely adherent to one another.

The **skin of the scalp** is thicker than that of any other part of the body. By means of the superficial fascia the skin is closely adherent to the occipito-frontalis muscle and aponeurosis, which accounts for the movement of the skin with the muscle and its aponeurosis. It is rich in sebaceous glands which, when enlarged on account of occlusion of their ducts, constitute sebaceous cysts or wens, so common in this region. These growths, even when large, except in very rare instances, are superficial to the occipito-frontalis aponeurosis, and with care can, therefore, be removed without risk of opening the areolar tissue layer. The skin is well nourished by the vessels of the superficial fascia.

The **superficial fascia of the scalp** consists of but one layer, which presents a granular appearance, due to the nodulated fat and dense fibrous septa. Its septa firmly connect the skin to the occipito-frontalis aponeurosis. In its density and capability of resisting pressure it is like the superficial fascia of the palm of the hand and sole of the foot. It is continuous behind with the superficial fascia of the back of the neck; laterally, and in front, with the superficial fascia of the face. It contains the principal blood-vessels and nerves of the scalp, in this respect differing from the superficial fascia elsewhere, with the exception of that of the face and ischio-rectal fossæ, the muscles of the auricle, and the hair-bulbs. The arteries of the scalp lie, as it were, in canals in the fascia, and are attached to the walls of these canals by loose fibrous tissue; when divided, they have a slight tendency to retract within these channels or canals, and, on account of the density of the fascia, it may be difficult to seize them with the artery forceps. Consequently, some form of pressure is often employed to check the bleeding. The presence of the hair-bulbs in this dense fascia and their firm attachment to the scalp enable a strong person, by securely grasping the hair, to lift the entire weight of the body without tearing out the hair-roots. Owing to the density of the superficial fascia, redness and swelling are not very pronounced in inflammation of the scalp. The superficial fascia is thickest in the occipital region, and gradually grows thinner as it approaches the front and sides of the cranium.

Wounds of the scalp bleed freely, because the arteries can not contract or retract on account of the density of the superficial fascia and their close adherence

Anterior temporal a.
Posterior temporal a.
Supraorbital a.
Posterior auricular a.
Frontal a.
Occipital a.

and nerves are to be removed as one common layer, bringing into view the corresponding half of the occipito-frontalis aponeurosis and muscle; while upon the other side only the superficial fascia in the immediate neighborhood of the vessels and nerves is to be removed, in this way exposing and giving a clear idea of the blood and nerve supply of the scalp. In reflecting the superficial fascia preserve the attolens and attrahens aurem muscles which lie between it and the aponeurosis.

The **Extrinsic Muscles of the Ear** are very feeble and rudimentary, the auricle in man being practically immovable. They are three in number—the attolens aurem, attrahens aurem, and retrahens aurem; they require considerable care in dissection to avoid being overlooked and destroyed.

Dissection.—Draw the pinna downward and fasten it with hooks; this will make tense the attolens and attrahens aurem muscles.

The **attolens aurem,** the largest of the three muscles, is broad and fan-shaped, converging to a narrow tendon below. It arises from the superficial surface of the occipito-frontalis aponeurosis below the temporal ridge, and is inserted into the cranial aspect of the upper part of the pinna.

Nerve Supply.—From the temporal branch of the facial nerve.

Action.—It draws the pinna upward.

The **attrahens aurem** is the smallest muscle of the three, and arises from the occipito-frontalis aponeurosis in front of the attolens aurem muscle, and is inserted into the front of the helix.

Nerve Supply.—From the temporal branch of the facial nerve.

Action.—It draws the pinna forward and upward.

Dissection.—Release the pinna from its present position and draw it forward; fasten it with hooks, and divide the integument over the tense band behind the auricle to expose the retrahens aurem muscle.

The **retrahens aurem** muscle consists of two or three short muscular bundles which arise from the mastoid process of the temporal bone and are inserted into the back of the concha.

Nerve Supply.—From the posterior auricular branch of the facial nerve.

Action.—It draws the pinna backward.

The **Arteries of the Scalp** are derived, in front, from the supra-orbital and

The **frontal artery,** one of the two terminal branches of the ophthalmic, leaves the orbit at its inner angle and ascends on the forehead, anastomosing with the supra-orbital and with the frontal artery of the opposite side.

The **temporal artery,** the smaller of the two terminal divisions of the external carotid, commences in the substance of the parotid gland and ascends over the posterior root of the zygoma, about two inches above which it divides into the *anterior and posterior temporal;* in some cases it divides immediately after crossing the zygoma; rarely, it divides below the zygoma. It is accompanied by branches of the facial and auriculo-temporal nerves. It is covered by the attrahens aurem muscle and crossed by one or two small veins. The temporal and anterior temporal arteries are the vessels used by the anesthetizer to ascertain the character of the pulse.

The *anterior temporal artery* passes forward in a tortuous course to anastomose with the supra-orbital and frontal arteries and with the anterior temporal artery of the opposite side. It supplies the tissues along its course. It is the branch usually selected when blood is to be extracted from the arterial system.

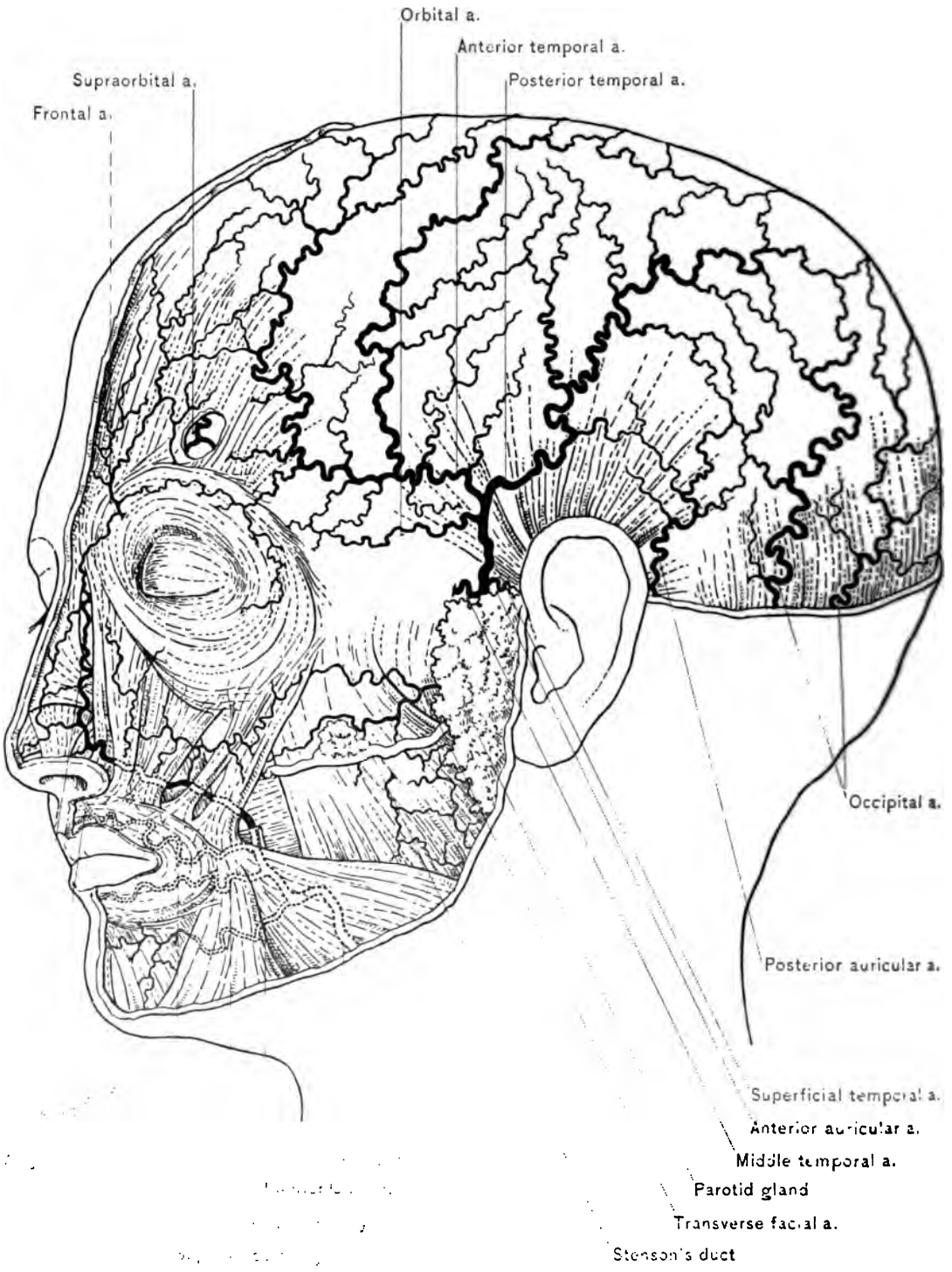
The *posterior temporal artery,* the larger of the two, passes upward and backward above the pinna and anastomoses with the posterior temporal artery of the opposite side and with the occipital and posterior auricular arteries.

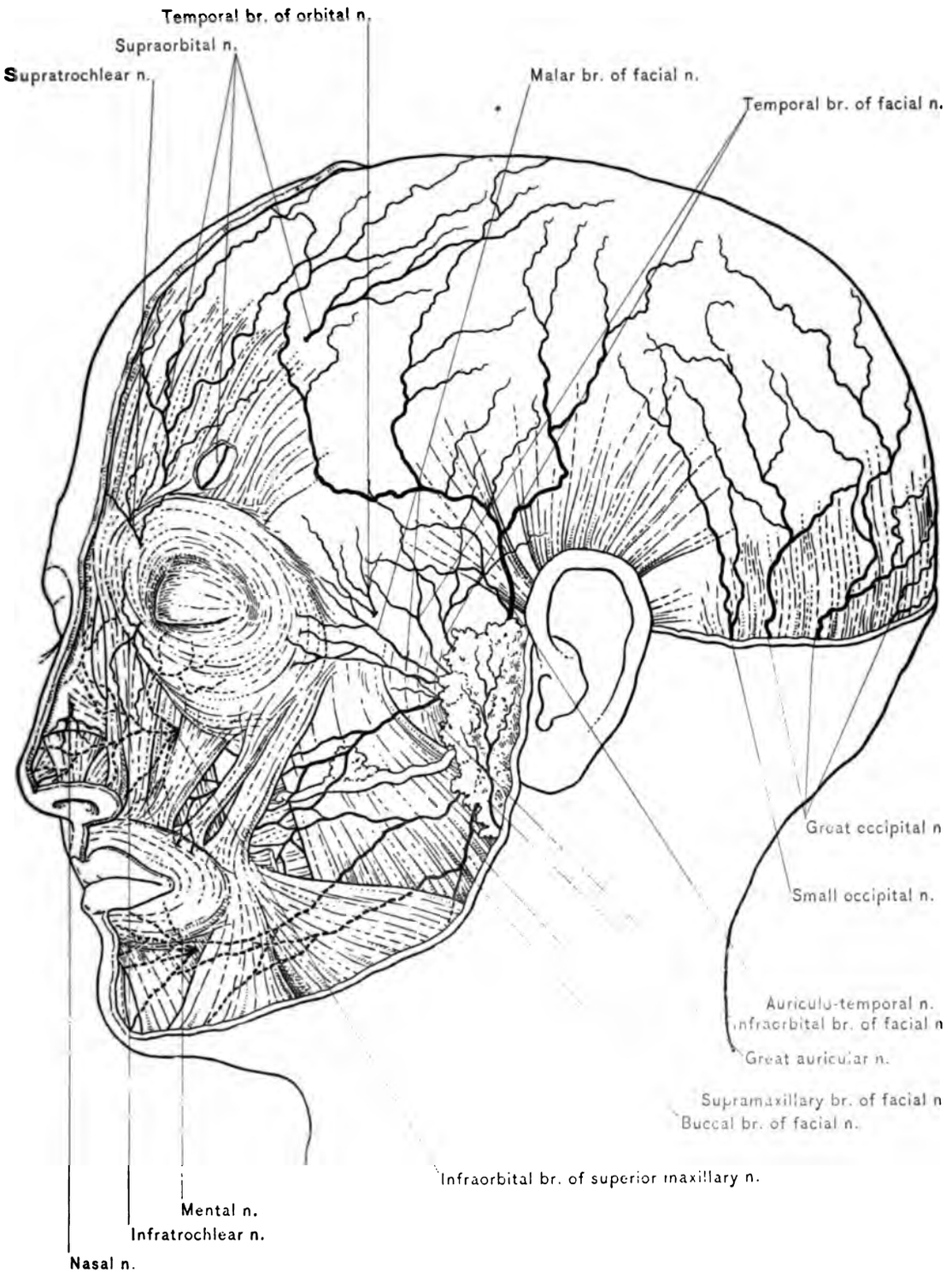
The transverse facial, anterior auricular, and middle temporal branches of the temporal artery will be described with the dissection of the face.

The *posterior auricular artery* passes over the mastoid process, and divides into two branches—an anterior and a posterior. The anterior branch passes forward and anastomoses with the posterior temporal artery; the posterior branch passes backward and anastomoses with the occipital artery. It is accompanied by the posterior auricular nerve, a branch of the facial nerve.

The **occipital artery** pierces the trapezius muscle at its attachment to the superior curved line of the occipital bone, about midway between the mastoid

PLATE CXXIV.


Orbital a.
Anterior temporal a.
Supraorbital a.
Posterior temporal a.
Frontal a.
Occipital a.
Posterior auricular a.
Superficial temporal a.
Anterior auricular a.
Middle temporal a.
Parotid gland
Transverse facial a.
Stenson's duct


Temporal br. of orbital n.
Supraorbital n.
Supratrochlear n.
Malar br. of facial n.
Temporal br. of facial n.
Great occipital n
Small occipital n.
Auriculo-temporal n.
Infraorbital br. of facial n
Great auricular n.
Supramaxillary br. of facial n
Buccal br. of facial n.
Infraorbital br. of superior maxillary n.
Mental n.
Infratrochlear n.
Nasal n.

immediately after operation is good presumptive evidence of the existence of an accessory foramen.

Temporal branch of the orbital nerve.—About an inch above the zygoma the temporal fascia is pierced by the temporal branch of the orbital branch of the superior maxillary nerve, which is distributed to the integument of the temple and communicates with the temporal branch of the facial nerve.

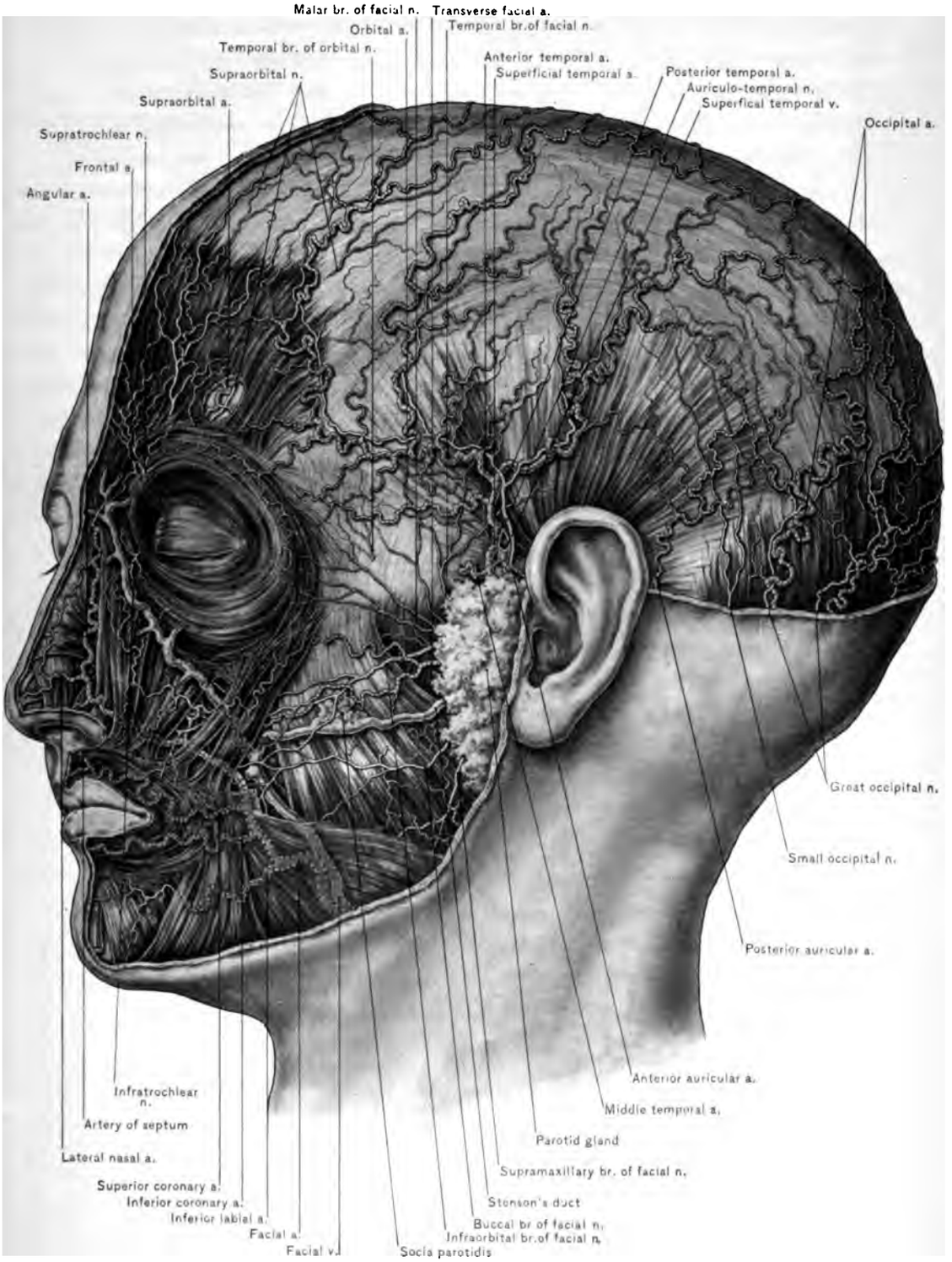
The **auriculo-temporal nerve,** a branch of the inferior maxillary nerve, accompanies the temporal vessels, lying posterior to them. The auriculo-temporal nerve emerges from beneath the upper part of the parotid gland, and divides into two terminal branches—the anterior and posterior temporal. The anterior temporal nerve, the larger, accompanies the anterior temporal artery to the vertex, and communicates with the facial and temporo-malar nerves. The posterior temporal nerve, the smaller, accompanies the posterior temporal artery.

Temporal branches of the facial nerve extend upward over the zygoma upon the temple to supply the attrahens and attolens aurem, the orbicularis palpebrarum, the frontalis, and the corrugator supercilii muscle. They communicate with the temporo-malar, auriculo-temporal, lacrymal, and supra-orbital nerves.

The **posterior auricular nerve,** a branch of the facial, accompanies the posterior auricular artery, and, like the latter, divides into two branches—a posterior and an anterior. The posterior (occipital) supplies the occipitalis muscle; the anterior (auricular), the auricle and the retrahens and attolens aurem muscles. This nerve is joined by filaments from the auricular branch of the pneumogastric nerve and from the great auricular and small occipital nerves.

The **small occipital nerve** (occipitalis minor), a branch of the anterior division of the second cervical nerve, supplies the scalp behind the ear and over the occiput. It communicates with the great auricular and the great occipital nerve, and with the posterior auricular branch of the facial nerve. It can be seen in the neck running along the posterior border of the sterno-mastoid muscle.

The **great occipital nerve** (occipitalis major), the largest cutaneous nerve of the scalp, accompanies the occipital artery over the occiput. It is the internal branch of the posterior division of the second cervical nerve; pierces the complexus and trapezius muscles near their attachment to the occipital bone; enters the superficial fascia with the occipital artery, and breaks up into a number of large branches which spread over the back of the head, supplying the integument as far forward as the vertex. It communicates with the small occipital and the


Malar br. of facial n.
Transverse facial a.
Orbital a.
Temporal br.of facial n.
Temporal br. of orbital n.
Anterior temporal a.
Supraorbital n.
Superficial temporal a.
Posterior temporal a.
Auriculo-temporal n.
Supraorbital a.
Superfical temporal v.
Occipital a.
Supratrochlear n.
Frontal a.
Angular a.
Great occipital n.
Small occipital n.
Posterior auricular a.
Anterior auricular a.
Infratrochlear n.
Middle temporal a.
Artery of septum
Parotid gland
Lateral nasal a.
Supramaxillary br. of facial n.
Superior coronary a.
Stenson's duct
Inferior coronary a.
Buccal br of facial n.
Inferior labial a.
Infraorbital br.of facial n.
Facial a.
Facial v.
Socia parotidis

lateral, or posterior auricular, set enter the posterior auricular glands situated upon the mastoid attachment of the sterno-mastoid muscle; the temporal lymphatics enter the glands situated upon and within the parotid gland; and a frontal set end in the facial lymphatics. In congestion of the scalp due to cold, and in other affections of this region which increase the activity of the lymphatics, these glands are considerably swollen and painful.

The occipito-frontalis muscle and aponeurosis, exposed upon the side from which the superficial fascia has been removed, will now be studied.

The **occipito-frontalis** is a broad, musculo-aponeurotic layer covering one side of the vertex of the skull from the occiput to the brow. It consists of two flattened muscular bellies, an occipital and a frontal, with an intervening aponeurosis.

The *occipital belly* (*occipitalis muscle*), thin and quadrangular, arises from the outer two-thirds of the superior curved ridge of the occipital bone and the adjoining mastoid process, thus leaving a triangular interval between the two occipitales muscles as their fibers eventually meet higher up in the median line. The fibers are about an inch and a half in length and ascend to the aponeurosis.

BLOOD SUPPLY.—From the occipital and posterior auricular arteries.

NERVE SUPPLY.—The occipitalis muscle derives its nerve supply from the posterior auricular branch of the facial and, exceptionally, from the occipitalis minor nerve.

The *frontal belly* (*frontalis muscle*), a thin, muscular layer having intimate cutaneous connections, arises from the aponeurosis below the coronal suture. It descends over the forehead and blends with the orbicularis palpebrarum, the corrugator supercilii, and the pyramidalis nasi muscle.

BLOOD SUPPLY.—From the frontal, supra-orbital, and anterior temporal arteries.

NERVE SUPPLY.—The frontalis muscle derives its nerve supply from the temporal branch of the temporo-facial division of the facial nerve.

The *aponeurosis* extends over the vertex and is continuous across the middle line with the aponeurosis of the opposite side; laterally it is continued over the temporal fascia to the zygoma, just above which it is attached to that fascia. Connected

brow and produces wrinkling of the forehead; if contraction be continued, it draws the scalp forward, and pulls up the skin of the nose, to the extent even of moving the naso-labial folds; contraction of the occipital belly draws the scalp backward and alternate contraction of the two bellies moves the scalp backward and forward.

DISSECTION.—Divide the aponeurosis in the median line, and make another incision at its junction with the frontalis muscle. Reflect the aponeurosis outward and backward, and the frontalis muscle downward.

Areolar tissue layer.—The mobility of the scalp depends entirely upon the laxity of the subjacent areolar tissue layer; it is this layer which permits extensive flaps of the scalp to be torn loose. When the hairs become caught in moving machinery the entire scalp may be torn off, laying this tissue bare. It was due to the laxity of this layer that the American Indian, with no knowledge of anatomy or surgery, was able to peel off the scalp with so much ease. Exposure of the skull in a postmortem examination is effected by peeling off the scalp along this layer of tissue, and it is remarkable with what ease the skull can thus be exposed. To further illustrate the laxity of this tissue, it will suffice to relate a case mentioned by the late D. Hayes Agnew: A midwife attending a woman in child-birth incised the child's scalp, thinking it the protruding bag of waters. Labor pains came on, and the head protruded through the scalp wound with the entire vault of the skull laid bare.

Tumors.—By careful examination tumors situated above the occipito-frontalis aponeurosis or in it will be seen to be freely movable. All immovable growths of the scalp should be most carefully examined before extirpation, for they are probably beneath the aponeurosis; a tumor originating within the cranium may force its way outward and form a prominence on the scalp.

Wounds involving only the skin and superficial fascia of the scalp, when the occipito-frontalis muscle or its aponeurosis has not been divided, do not gape, because of the close adherence of the skin to the superficial fascia and of the superficial fascia to the aponeurosis. The areolar tissue layer permits of wide separation of the edges of a wound which divides the occipito-frontalis aponeurosis. Antero-posterior wounds which involve the aponeurosis gape but little, while the edges of transverse wounds are widely separated by the contraction of the occipito-frontalis muscle. The great vascularity of the scalp lessens the likelihood of sloughing and gangrene. A large flap of the scalp attached by but a small pedicle is much less likely to perish than a flap of skin torn from another part of the body, as the vessels of the scalp run immediately beneath the skin and are included in the flap. In phlegmonous erysipelas and in deep inflammation of the scalp the areolar tissue layer becomes infiltrated with pus and consequently sloughs. As the vessels are superficial to this layer the skin does not

necrose, ulcerate, and allow pointing, and for this reason it is important to incise early.

The **pericranium** (external periosteum) is but loosely attached to the bone, except at the sutures, where the union is firm. In lacerated wounds of the scalp the pericranium is frequently stripped from the skull to the extent of exposing large areas of bone. The pericranium differs in its functions from the periosteum covering other bones in that, if the periosteum be removed to any extent from another bone, the part of the bone from which it is removed will most probably necrose, while the pericranium may be stripped from a considerable part of the vault of the cranium without necrosis following. This is due to the fact that the bones of the skull receive their blood supply chiefly from the vessels of the external (endosteal) layer of the dura mater, while the other bones are nourished to a great extent through their periosteal covering. The pericranium at the sutures becomes continuous with the external layer of the dura mater, constituting the so-called intersutural membrane. It is also continuous with the dura at the foramina ; hence it is that inflammation of the pericranium may extend by continuity and involve the dura mater, producing pachymeningitis.

Collections of blood or pus in the scalp may be situated superficial to the occipito-frontalis aponeurosis, between the aponeurosis and the pericranium or beneath the pericranium. A collection superficial to the aponeurosis is of but little moment, since the density of the superficial fascia causes it to be circumscribed. Collections in the areolar tissue layer, between the aponeurosis and the pericranium, are limited only by the attachments of the occipito-frontalis muscle and its aponeurosis ; thus they may undermine the entire scalp and prove serious if not evacuated early. Collections beneath the pericranium are limited to a single bone, on account of the sutural attachments of the membrane. Collections in the areolar tissue layer call for drainage, and should they be slow in healing, the scalp must be firmly bandaged in order to arrest the movements of the occipito-frontalis muscle. Hematomata in the areolar tissue layer are uncommon, except as a result of fissured fracture of the skull with rupture of one of the branches of the middle meningeal artery, or of the superior longitudinal or lateral sinus, as the areolar tissue between the aponeurosis and the pericranium contains but very

the mastoid vein which empties into the lateral sinus. Through the anastomoses between the diploic veins and the veins of the pericranium septic material in the scalp may reach the sinus alæ parvæ and the cavernous sinus through the fronto-sphenoid diploic vein, the superior petrosal sinus through the anterior temporal diploic vein, and the lateral sinus through the posterior temporal and occipital diploic veins. In erysipelas, abscess, and other infectious inflammations of the scalp germs may enter the sinuses through these various routes and cause thrombosis, embolism, and pyemia.

Temporal fascia.—The temporal fascia is a white, shining membrane, which is stronger than the occipito-frontalis aponeurosis in this location, and which gives attachment by its under surface to the superficial fibers of the temporal muscle. Above, it is attached to the entire extent of the temporal ridge as a single layer; while below, it divides into two layers, the outer of which is attached to the external and the inner to the internal border of the upper margin of the zygomatic arch and zygomatic process of the malar bone. Between these two layers are seen a small quantity of fat, the orbital branch of the middle temporal artery, and the temporal branch of the temporo-malar or orbital branch of the superior maxillary nerve. In relation with its outer surface is the extension of the occipito-frontalis aponeurosis, the orbicularis palpebrarum, the attolens and attrahens aurem muscles, the temporal vessels, the auriculo-temporal nerve, and the temporal branches of the orbital and facial nerves. Immediately above the zygoma it is pierced by the middle temporal artery, a branch of the temporal.

Density of the temporal fascia.—Owing to the density of this fascia abscesses beneath it very rarely point upon the surface, the pus passing in the direction of least resistance—namely, through the pterygo-maxillary region into the mouth or neck. Its unyielding nature is well illustrated by a case recorded by Denonvilliers: "A woman who had fallen in the street was admitted to the hospital with a deep wound in the temporal region; a piece of bone several lines in length was found loose at the bottom of the wound and was removed. After its removal the finger could be passed through an opening with an unyielding border, and came in contact with some soft substance beyond. The case was considered one of compound fracture of the squamous portion of the temporal bone, with separation of a fragment and exposure of the brain. A bystander, however, noticed that the bone removed was dry and white. A more thorough examination of the wound revealed the fact that the skull was uninjured, that the supposed hole in the skull was merely a laceration of the temporal fascia, that the soft matter beyond was muscle and not brain, and that the fragment removed was simply a piece of bone, which, lying on the ground, had been driven into the soft parts when the woman

PLATE CXXVII.

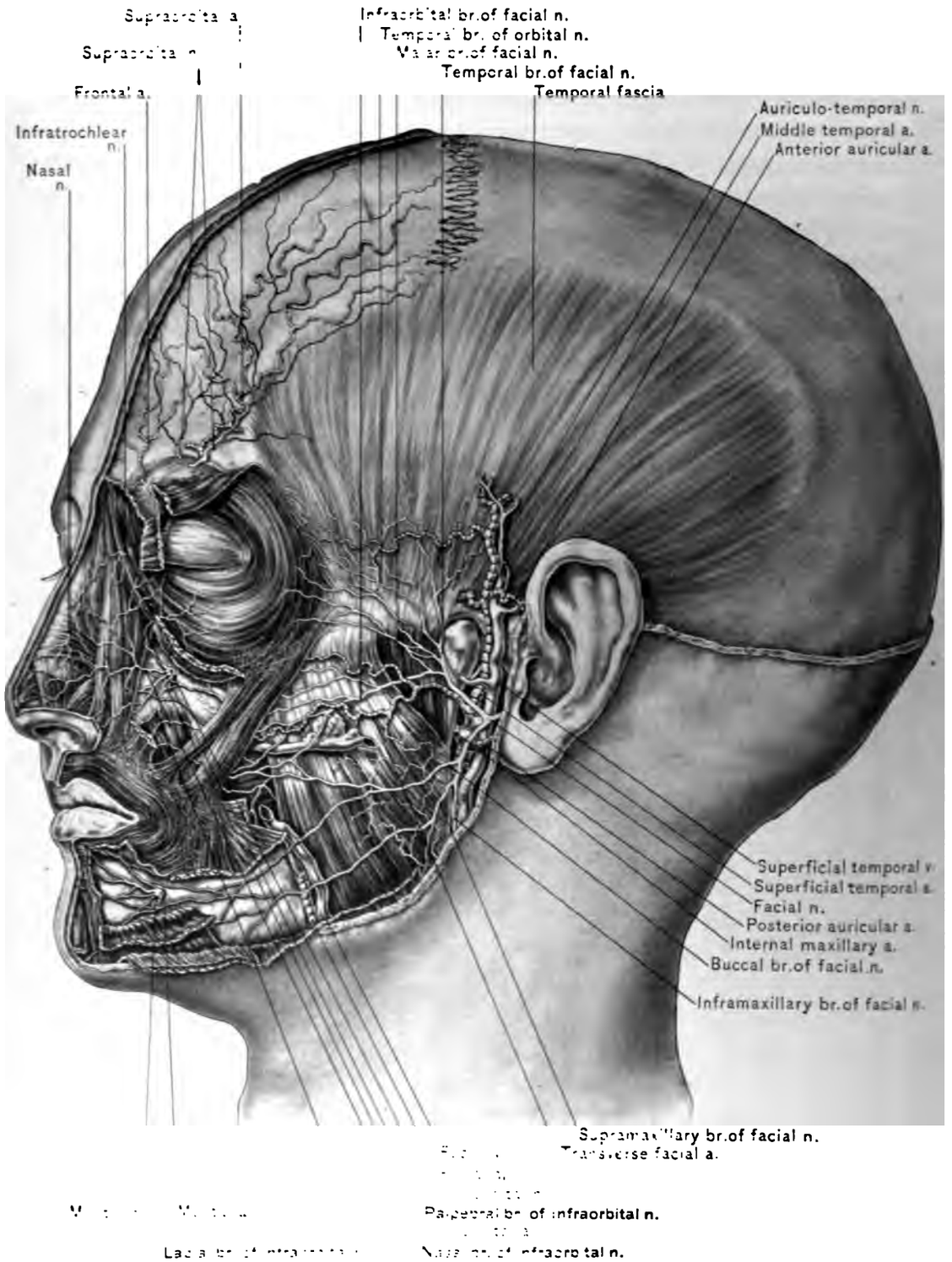
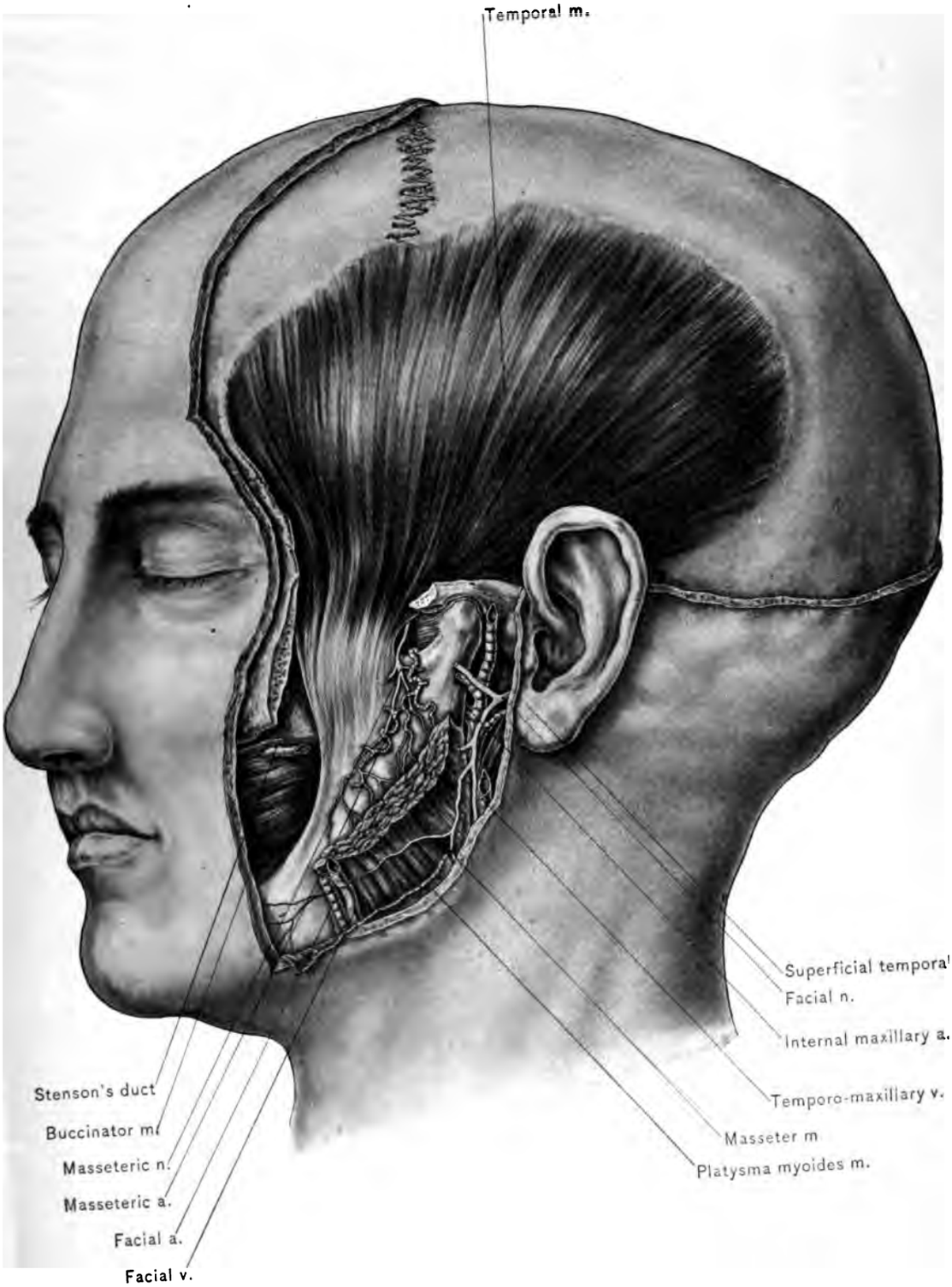
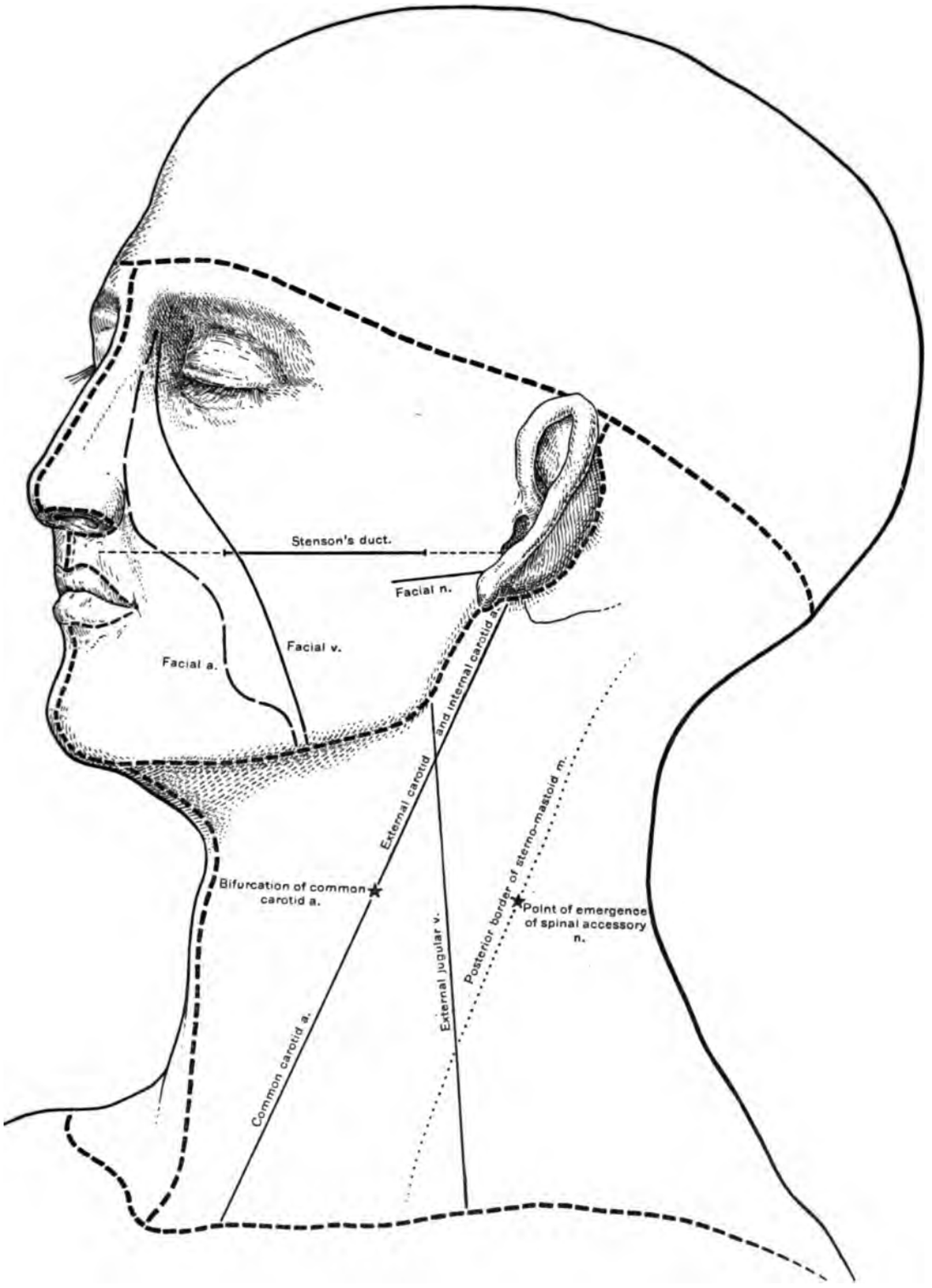


PLATE CXXVIII.



PLATE


Stenson's duct.
Facial n.
Facial v.
Facial a.
External carotid and internal carotid a.
Posterior border of sterno-mastoid m.
Bifurcation of common carotid a.
Point of emergence of spinal accessory n.
External jugular v.
Common carotid a.

DISSECTION.—The temporal fascia should now be detached from the zygomatic arch and reflected upward, when the greater portion of the temporal muscle and a quantity of fat overlying the muscle above the zygoma will be exposed. The tendon of insertion of the muscle will be seen in dissecting the face.

The **temporal muscle,** broad, flat, and triangular, is situated on the side of the head, and occupies the temporal fossa. It arises from the under surface of the temporal fascia and from the whole of the temporal fossa, whence its fibers descend and converge to a tendon which passes under the zygomatic arch to be inserted into the apex, the inner surface, and the fore part of the coronoid process of the lower jaw down to the last molar tooth.

BLOOD SUPPLY.—From the middle and deep temporal arteries.

NERVE SUPPLY.—Derived from the temporal branches of the *inferior maxillary nerve.*

ACTION.—The action of the temporal muscle is to elevate the lower jaw; its posterior fibers also assist in drawing the lower jaw backward after other muscles have carried it forward.

FACE.

DISSECTION.—The dissection of the face should follow that of the scalp. The head should be placed in the same position as for the dissection of the scalp, but slightly lower, and turned so that the side of the face to be dissected is upward. The cheeks and nostrils should be distended with cotton or oakum and the lips sewed together. The muscles and vessels should be dissected on one side of the face and the nerves on the other. The incisions are made as follows: The first incision is made from the nasal eminence along the median line of the nose, around the aperture of the nostril, along the median line of the upper lip, around the mouth along the line where the skin joins the mucous membrane to the median line of the lower lip, and thence to the point of the chin. A second incision is carried along the lower border of the jaw to the angle of the jaw, then upward to the lobe of the ear. Reflect the skin outward. The facial muscles (muscles of expression) are inserted partly into the skin, and great care must be taken that they are not removed with the skin.

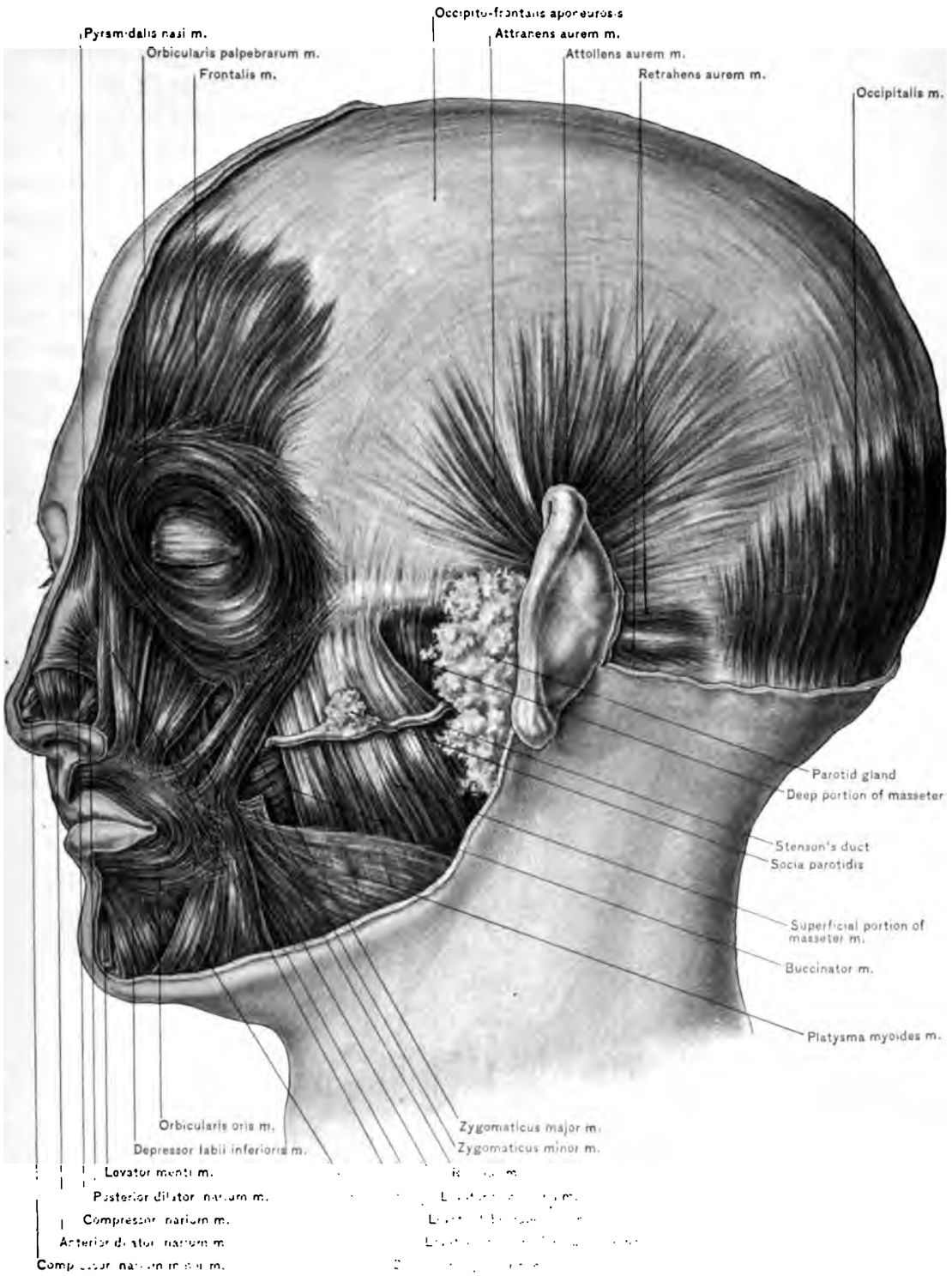
The **skin of the face** is remarkably thin, and freely supplied with vessels and nerves. On account of the free blood supply it is a common site of nevi, except

of a layer of lax cellular tissue, is loosely adherent to the parts beneath. Over the cartilages of the nose the skin is so intimately adherent to the tissues beneath that it is removed with difficulty. It is very freely supplied with sebaceous and sudoriferous glands, and hence is commonly the site of acne and eruptions which especially involve the sebaceous follicles; it is also the site of sebaceous tumors. Facial abscesses usually point quickly and seldom attain large size.

The **superficial fascia**—the cellular tissue layer of the face—contains a considerable amount of fat, except in the eyelids and over the bridge of the nose. The laxity of the cellular tissue favors the spreading of infiltrations, so that the cheeks and other parts of the face may become greatly swollen. In general dropsy the face soon becomes puffy, the edema first appearing, as a rule, in the lax areolar tissue of the lower eyelid. The soft tissues of the cheek favor the spread of destructive processes. In cancrum oris—a form of gangrene of the mouth attacking the young—the whole cheek may be lost in a few days. Great contraction is apt to follow upon loss of substance, so that the jaw may be firmly closed in some cases, as is seen after recovery from deep ulceration (Treves). The mobility of the tissues of the face renders this region favorable for the performance of plastic operations, and their vascularity insures a prompt and perfect union. Notwithstanding the fact that there is a large quantity of fat in the subcutaneous tissue, fatty tumors are rarely seen in this region. The thickness of the tissues of the cheeks and lips favors the embedding of foreign substances in these parts. Thus, a tooth which has been knocked out has remained embedded in the lip. Henry Smith reported a remarkable case in which he removed a piece of tobacco-pipe three inches long from the cheek, where it had remained for several years.

Dissection.—The superficial fascia—underlying which are the muscles, vessels, and nerves—should be removed in the same manner as the skin, taking care not to disturb the muscles. As the superficial fascia is not easily removed in a continuous layer, it may be taken away in sections, the dissection being made in the line of the muscular fibers; this is necessary, too, in order to avoid dividing the blood-vessels and nerves of the face. The removal of the fascia in this manner exposes the muscles, the vessels, and the nerves.

The **Muscles of the Face** (muscles of expression) are divided into three groups: those of the nose, those of the eyebrows and eyelids, and those of the


Occipito-frontalis aponeurosis
Pyramidalis nasi m.
Attrahens aurem m.
Orbicularis palpebrarum m.
Attollens aurem m.
Frontalis m.
Retrahens aurem m.
Occipitalis m.
Parotid gland
Deep portion of masseter
Stenson's duct
Socia parotidis
Superficial portion of masseter m.
Buccinator m.
Platysma myoides m.
Orbicularis oris m.
Zygomaticus major m.
Depressor labii inferioris m.
Zygomaticus minor m.
Levator menti m.
Posterior dilator nasi m.
Compressor nasi m.
Anterior dilator nasi m.

the nose, where it joins the lower edge of the nasal bone and the compressor nasi muscle.

NERVE SUPPLY.—From the infra-orbital branch of the temporo-facial division of the facial nerve.

ACTION.—It renders the skin over the cartilages tense, and that over the root of the nose lax, thus forming the transverse crease at the root of the nose.

The **compressor nasi muscle** is triangular in shape, arises by its apex from the canine fossa of the superior maxillary bone, and ends in the aponeurosis covering the cartilaginous part of the nose, blending with the corresponding muscle of the opposite side. The origin of this muscle is concealed by the levator labii superioris alæque nasi muscle.

NERVE SUPPLY.—From the infra-orbital branch of the upper division of the facial nerve.

ACTION.—It throws the skin at the side of the nose into vertical wrinkles, aids in the elevation of the upper lip, and slightly compresses the cartilaginous ridge of the nose.

When the compressor nasi muscle is reflected from the median line outward, the superficial branch (naso-labial) of the nasal nerve, which becomes subcutaneous between the nasal bone and the lateral nasal cartilage, will be seen running downward to the tip of the nose.

The **levator labii superioris alæque nasi muscle,** placed by the side of the nose and overlapping the origin of the compressor nasi muscle, arises from the upper part of the nasal process of the superior maxilla. It descends, and divides into two portions: the inner and smaller part is inserted into the inner side of the ala nasi, and the outer into the upper lip, blending with the orbicularis oris muscle. It is partially overlapped near its origin by the orbicularis palpebrarum muscle.

NERVE SUPPLY.—From the infra-orbital branch of the facial nerve.

ACTION.—It raises the inner half of the upper lip, and draws outward the wing of the nose, thus dilating the anterior naris.

The **dilator naris muscle** consists of two portions—an anterior and a posterior. The anterior portion is a thin fasciculus which passes from the lower edge of the cartilage of the wing of the nose to the integument over the ala; the posterior portion arises from the margin of the nasal notch of the superior maxilla and from the outer surface of the sesamoid cartilages of the nose, and is inserted into the skin over the back and lower margin of the ala of the nose.

NERVE SUPPLY.—From the infra-orbital branch of the facial nerve.

ACTION.—It enlarges the anterior naris by raising and everting its outer edge, thus counteracting its tendency to be closed by atmospheric pressure. In conditions occasioning dyspnea—*e. g.*, laryngeal or tracheal obstruction—the action of

these muscles can plainly be seen, and constitutes one of the signs which indicate tracheotomy or intubation.

The **depressor alæ nasi** is a short, flat muscle which may be exposed when the upper lip is everted and its mucous membrane removed from the side of the labial frenum. It arises from the incisive fossa of the superior maxilla, whence its fibers ascend to be inserted into the septum nasi and the posterior lower part of the wing of the nose.

NERVE SUPPLY.—From the buccal branch of the cervico-facial division of the facial nerve.

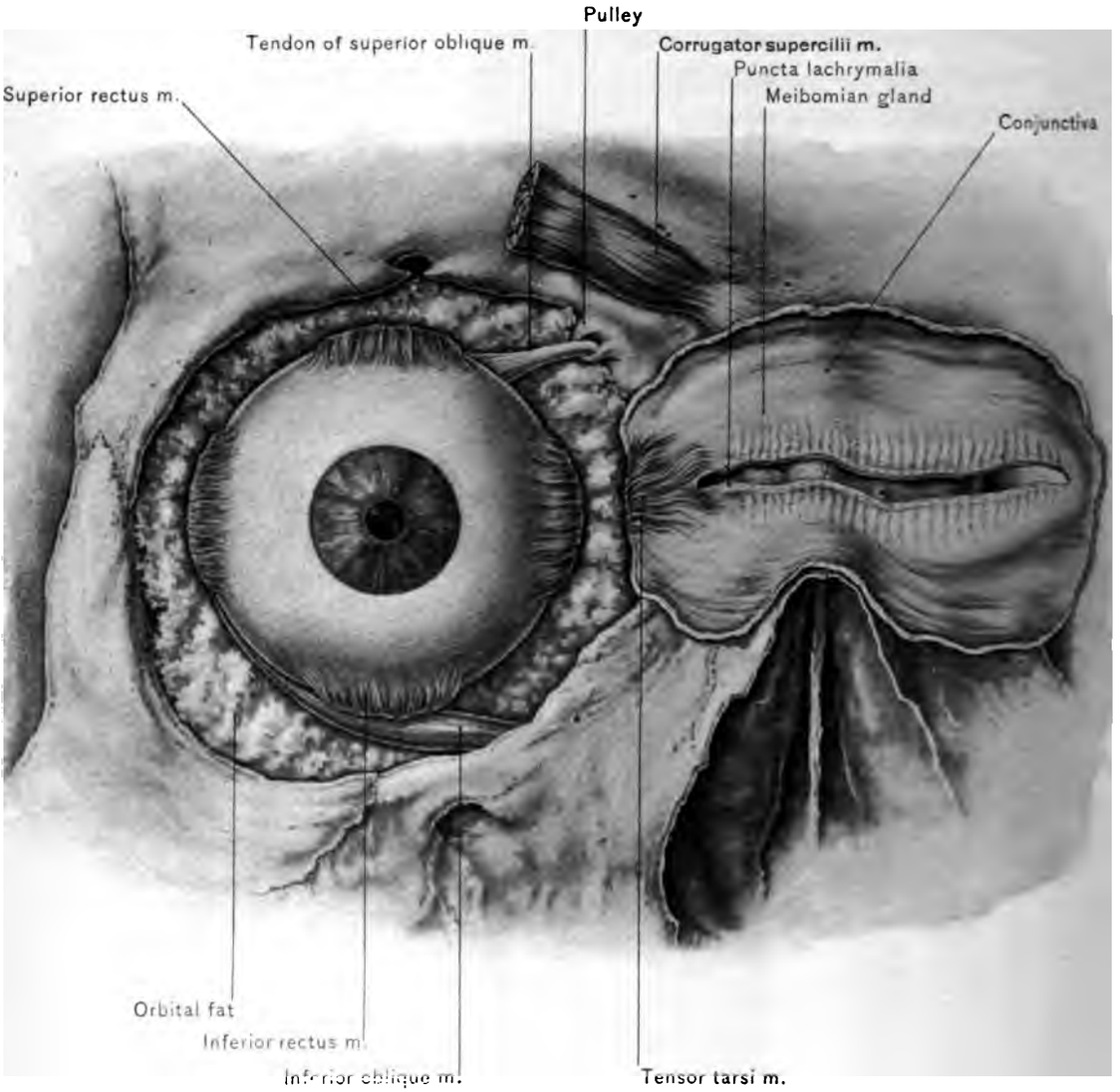
ACTION.—It draws downward and inverts the edge of the nasal cartilages.

The **Muscles of the Eyelids and Eyebrows** are the orbicularis palpebrarum, the corrugator supercilii, the levator palpebræ superioris, and the tensor tarsi.

Tendo oculi (tendo palpebrarum).—Before examining the orbicularis palpebrarum the tendo oculi (internal tarsal ligament) is to be noted. It is a short tendon, about one-sixth of an inch in length by one-twelfth of an inch in breadth, and can readily be felt at the inner angle of the eye after drawing the eyelids outward. It is attached to the nasal process of the superior maxilla in front of the lacrymal groove, passes transversely outward in front of the lacrymal sac, and divides into two portions, separated by the caruncula lachrymalis; the upper portion is attached to the inner extremity of the upper, and the lower to the inner extremity of the lower, tarsal cartilage. As the tendon crosses the lacrymal sac it gives off a strong aponeurotic lamina, which covers the sac and is attached to the margin of the lacrymal groove. This expansion will be seen on reflecting that portion of the orbicularis palpebrarum muscle which covers the lacrymal sac. To puncture the lacrymal sac a knife is inserted below the tendo oculi in a direction downward and a little backward, dividing the skin, the orbicularis palpebrarum muscle, and the fibrous expansion derived from the tendo oculi. The angular artery and vein are situated on the inner side of the incision.

The **external tarsal ligament** extends, undivided, transversely inward from the edge of the frontal process of the malar bone to the adjacent outer extremities

PLATE CXXXI.


Pulley
Tendon of superior oblique m.
Corrugator supercilii m.
Puncta lachrymalia
Meibomian gland
Superior rectus m.
Conjunctiva
Orbital fat
Inferior rectus m.
Inferior oblique m.
Tensor tarsi m.

nally with the tendo oculi and externally with the external tarsal ligament and the malar bone, constitute the *palpebral portion* of the muscle. The fibers of this portion, which are in immediate relation with the eyelashes, have been described as the *ciliary muscle;* but this, however, must not be confounded with the ciliary muscle proper—the muscle of visual accommodation. More peripheral fibers constitute the *orbital portion* of the muscle. The latter arise from the internal angular process of the frontal bone and from the nasal process of the superior maxillary bone, and are distributed around the margin of the orbit. They are continuous above with the frontalis and corrugator supercilii muscles, and extend outward upon the cheek to mingle with the elevators of the upper lip and nose and with the zygomaticus minor muscle.

NERVE SUPPLY.—From the temporal and malar branches of the temporo-facial division of the facial nerve; hence in paralysis of this nerve the eyelids on the paralyzed side can not be closed.

ACTION.—The orbicularis palpebrarum muscle closes the eyelids and protects the eye. The palpebral portion of the muscle contracts during winking. Contraction of the orbital portion presses the eyeball backward into the orbit and draws the soft parts covering the margin of the orbit around the eyeball, thus protecting it from injury. While this cushion of tissue may be severely bruised, as is seen in a "black" eye, the eyeball itself is rarely injured. As the outer portion of the orbicularis is mingled with the fibers of the frontalis muscle and the elevators of the upper lip and nose, slight depression of the eyebrow and elevation of the upper lip and of the wing of the nose follow contraction of this portion. Strong contraction of the entire muscle holds the eye firmly in the orbit, thus protecting it against the severe strain in violent coughing, sneezing, and vomiting, during which acts the muscle usually contracts spasmodically. Contraction of the palpebral portion of the muscle following that of the orbicular portion tends to draw the lids slightly inward, thus directing the tears to the inner angle of the fissure between the eyelids, near which are situated the puncta lachry-

NERVE SUPPLY.—From the infra-orbital branch of the temporo-facial division of the facial nerve.

ACTION.—It compresses the lacrymal sac.

The **corrugator supercilii muscle** arises from the inner end of the superciliary ridge of the frontal bone. Its fibers are directed outward and a little upward to the under surface of the orbicularis palpebrarum and frontalis muscles, to be inserted into the former over the middle of the supra-orbital arch.

NERVE SUPPLY.—From the temporal branch of the temporo-facial division of the facial nerve.

ACTION.—It draws the eyebrow downward and inward, thus making the vertical wrinkle of the forehead at the inner extremity of the eyebrow.

DISSECTION.—The nasal half of the orbicularis palpebrarum and a small part of the frontalis muscle having been reflected inward, the corrugator supercilii is exposed.

The **levator palpebræ superioris muscle.**—By reflecting the outer as well as the nasal half of the orbicularis palpebrarum muscle, and detaching the orbito-tarsal ligament from the superior orbital margin and reflecting the ligament downward, the insertion of the levator palpebræ superioris muscle by a broad aponeurosis into the upper border of the tarsal cartilage of the upper eyelid can be seen.

The **Muscles of the Mouth** are the orbicularis oris, the levator labii superioris, the levator anguli oris, the zygomaticus major, the zygomaticus minor, the buccinator, the risorius, the depressor labii inferioris, the depressor anguli oris, and the levator labii inferioris.

The **risorius muscle** (Santorini's muscle), a part of the platysma myoides, consists of a thin bundle of fibers which arises from the fascia covering the masseter muscle and parotid gland, and passes horizontally forward to the angle of the mouth, where it joins the fibers of the orbicularis oris and depressor anguli oris muscles; some of its fibers pass to the skin at the angle of the mouth.

NERVE SUPPLY.—From the buccal branch of the lower division of the facial

corresponds in position with the red margin of the lips, and has no bony attachment, but is continuous around the angles of the mouth from one lip to the other. The outer, peripheral, or facial part is thinner and wider than the labial, and has a bony attachment as well as connection with the adjacent muscles. In the upper lip the orbicularis oris muscle is attached at each side of the middle line to the lower part of the septum nasi by naso-labial slips, and to the alveolar border of the upper jaw opposite the incisor teeth; in the lower lip it is attached to the alveolar border of the lower jaw opposite the canine teeth by a single fasciculus (musculi incisivi). The cutaneous surface of the muscle is intimately connected with the skin of the lips and surrounding parts. The intimacy of this union is so great in some instances that the mouth is surrounded by radiating wrinkles, especially marked in the upper lips of women. The labial integument of the male probably contains fewer wrinkles on account of the presence of large hair-bulbs. The deep surface of the orbicularis oris is covered by mucous membrane, between which and the muscle, in the submucous tissue, are the coronary arteries and the labial glands.

NERVE SUPPLY.—From the buccal and supra-maxillary branches of the cervico-facial division of the facial nerve.

ACTION.—When the facial and labial portions act conjointly, they press together and project the lips. The labial fibers acting alone bring the lips and the angles of the mouth together and invert the lips. The facial fibers acting alone press the lips against the alveolar borders of the jaws, and, at the same time, evert the lips. The orbicularis oris is the antagonist of all those muscles which converge to the lips from the various parts of the face. Hypertrophy of the orbicularis oris or, rather, an increase of the connective tissue, particularly of the portion in the upper lip, to the extent of producing a considerable deformity, is sometimes seen, and indicates a plastic operation involving the removal of a transverse, wedge-shaped section from the lip.

The **levator labii superioris muscle** (levator labii proprius) arises from the

The **levator anguli oris muscle** (musculus caninus) arises from the canine fossa of the superior maxilla below the infra-orbital foramen, and is inserted into the angle of the mouth, superficial to the buccinator muscle, its fibers blending with the orbicularis oris, the zygomatici, and the depressor anguli oris muscle.

NERVE SUPPLY.—From the infra-orbital branch of the upper division of the facial nerve.

ACTION.—It raises and draws inward the angle of the mouth.

The **depressor labii inferioris muscle** (quadratus menti) arises from the oblique line of the lower jaw by a wide origin, extending from a point below the foramen mentale nearly to the symphysis. Its fibers are associated with those of the muscle of the opposite side, ascend, and are inserted into the integument of the lower lip, blending with the orbicularis oris. Its outer border is overlapped by the depressor anguli oris muscle.

NERVE SUPPLY.—From the supra-maxillary branch of the cervico-facial division of the facial nerve.

ACTION.—It depresses and everts the lip.

The **depressor anguli oris muscle,** triangular in shape, hence also called triangularis oris, arises from the oblique line of the lower jaw external to the depressor labii inferioris muscles. Its fibers ascend, to be inserted into the angle of the mouth, intermingling with the zygomatici, the levator anguli oris, the risorius, and the orbicularis oris muscle. Its outer border overlaps the anterior part of the buccinator muscle.

NERVE SUPPLY.—From the supra-maxillary branch of the cervico-facial division of the facial nerve.

ACTION.—It draws the angle of the mouth downward and outward, producing an expression of sorrow.

The **levator labii inferioris,** or levator menti, is a small muscle seen by everting the lip and dissecting off the mucous membrane on each side of the labial frenum. It arises from the fossa below the incisor teeth, near the symphysis. Its fibers descend, and are inserted into the integument of the chin.

NERVE SUPPLY.—From the supra-maxillary branch of the cervico-facial division of the facial nerve.

ACTION.—It assists in raising the lower lip, at the same time wrinkling the

The **zygomaticus minor** arises from the outer part of the malar bone, anterior to the zygomaticus major, and behind the suture between the malar bone and the superior maxilla; its fibers pass downward and inward, to be inserted into the lower border of the levator labii superioris muscle. It is often absent.

NERVE SUPPLY.—From the infra-orbital branch of the temporo-facial division of the facial nerve.

ACTION.—The zygomaticus major draws the corner of the mouth upward and backward; the zygomaticus minor assists the levator labii superioris muscle in raising the upper lip.

Bucco-pharyngeal fascia.—Before making a dissection of the buccinator muscle, the thin layer of fascia which covers and adheres closely to its surface should be studied; it is attached to the alveolar borders of the superior and inferior maxillary bones, and posteriorly, where it is thickest, is continuous with the fascia over the constrictors of the pharynx. It is called by Holden the "bucco-pharyngeal fascia," since it supports and strengthens the walls of the pharynx and mouth. The density of the buccal fascia offers a barrier to the escape of pus into the mouth or pharynx from an abscess in the cheek.

The **buccinator,** quadrangular in form, is a thin, flat muscle which occupies the interval between the jaws at the side of the face. It arises from the outer surface of the alveolar borders opposite the middle and posterior molar teeth of the superior and inferior maxillæ, and behind from the pterygo-maxillary ligament. The *pterygo-maxillary ligament* is a fibrous band extending from the apex (hamular process) of the internal pterygoid plate of the pterygoid process to the posterior extremity of the internal oblique line (mylo-hyoid ridge) of the lower jaw; it separates the buccinator muscle from the superior constrictor of the pharynx. The fibers of the buccinator pass forward, to be inserted into the orbicularis oris muscle at the angle of the mouth. The central fibers intersect one another, while the upper fibers pass to the upper lip and the lower fibers to the lower lip. In relation with the superficial surface of the buccinator muscle is a large mass of fat (buccal pad), which separates it from the ramus of the lower jaw, the masseter muscle, a small portion of the temporal muscle, and the muscles converging to the angle of the mouth. Absorption of the fat overlying the muscle is followed by

by branches of the facial nerve. Internally it is lined by the mucous membrane of the mouth; between this and the muscle lie a number of racemose glands called the buccal glands. A few of these glands are found on the outer surface of the muscle and are called molar glands.

NERVE SUPPLY.—From the facial nerve. The long buccal nerve, a branch of the inferior maxillary, pierces the buccinator muscle on its way to supply the mucous membrane of the mouth.

ACTION.—The two buccinator muscles widen the aperture of the mouth transversely and contract and compress the cheeks so that during mastication the food will not remain between the cheeks and the teeth. When but one muscle acts, the angle of the mouth is drawn to that side, and the cheek is wrinkled; when whistling, the muscle contracts and prevents bulging of the cheeks.

It is hardly fair to the earnest dissector to leave this subject without the consoling reminder that the most expert dissectors can not bring out these muscles in the cadaver as they are shown in the anatomic plates. It must be remembered that some of the facial muscles belong to the panniculus carnosus group, so extensive in animals but so limited in man. In some faces the musculature is a complex network of subcutaneous fibers running in all directions. In a muscular subject a large number of distinct fasciculi are seen crossing one another, and more or less merged with the constant muscles of the face. This difference in the amount of facial musculature undoubtedly accounts for much of the variation in the amount of facial wrinkling observed in different persons. It is safe to say that a dissection of the muscles of the face with their boundaries as well defined as shown in pictures does more credit to the dissector's skill in imitating a diagram than to any painstaking effort to exhibit the natural state of the parts.

The **Facial Artery,** a branch of the external carotid, enters the face over the body of the lower jaw, at the anterior inferior angle of the masseter muscle, where its pulsation may readily be felt and it may be compressed against the bone. Thence it ascends forward across the cheek, over the buccinator muscle, and beneath the platysma myoides muscle, to the angle of the mouth; thence to the side of the nose, to terminate at the inner canthus of the eye as the angular artery. Where the artery passes over the lower jaw it is covered by the platysma myoides muscle and the deep fascia; near the mouth it passes beneath the zygomatici major and

PLATE CXXXII.

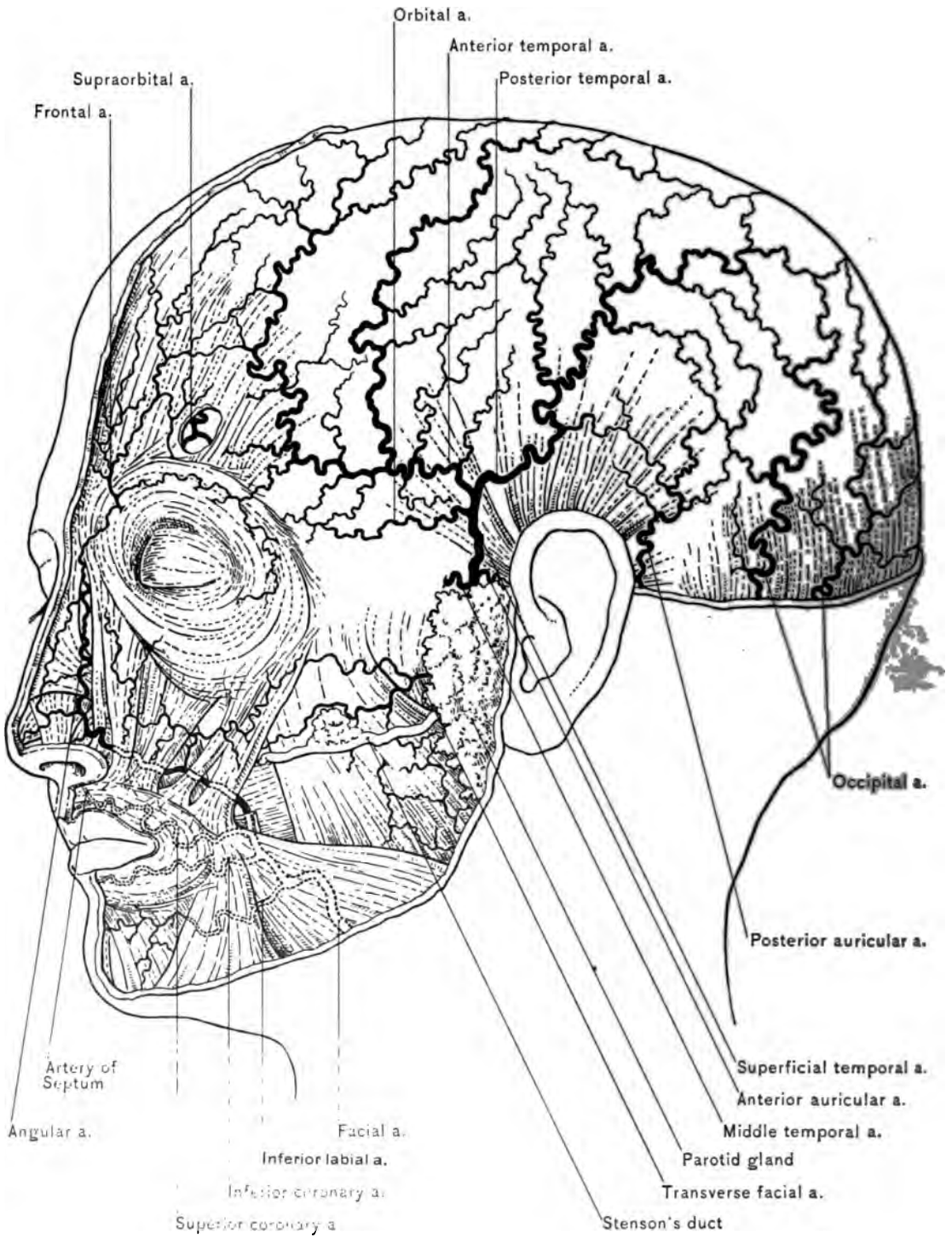
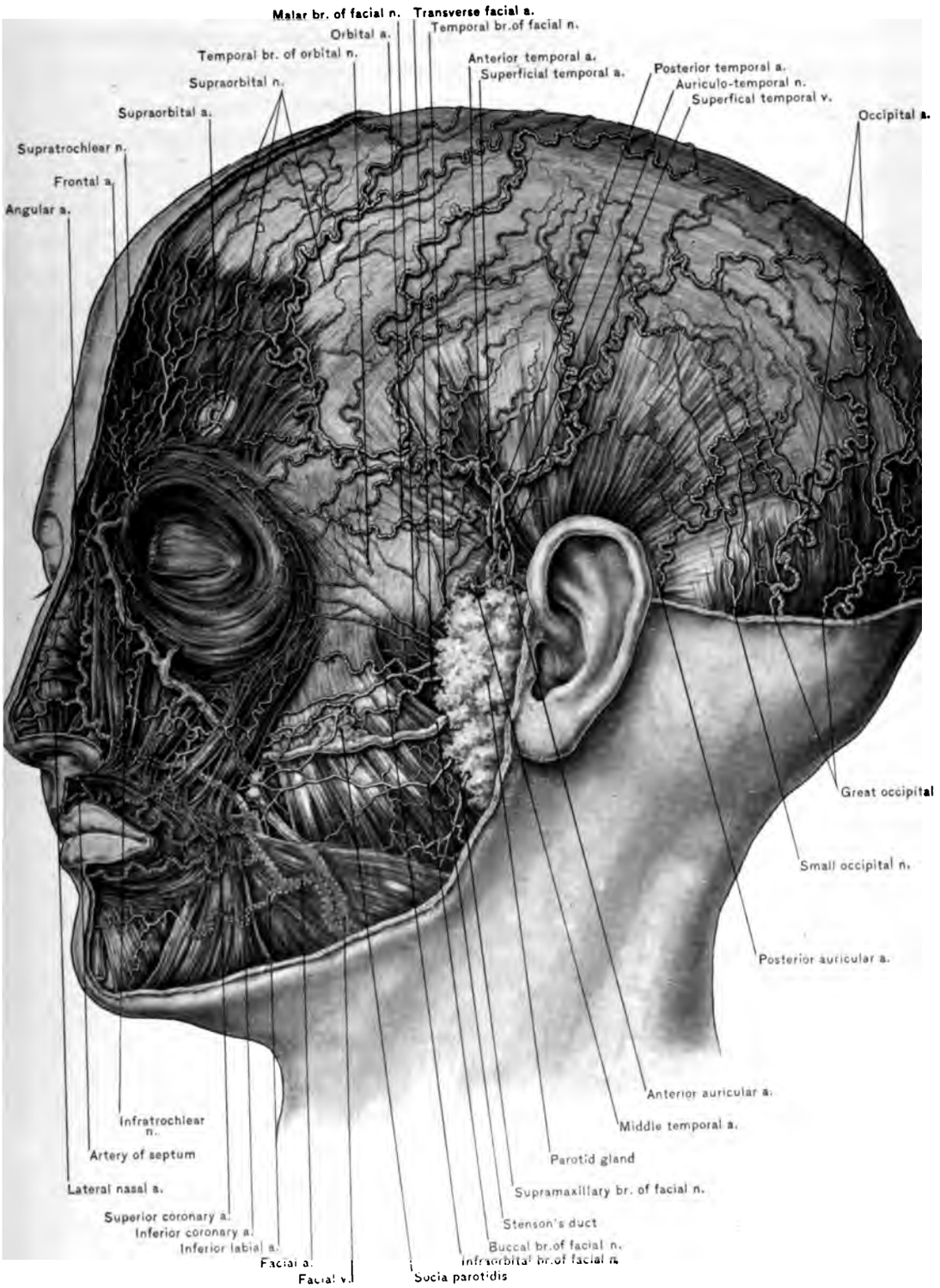
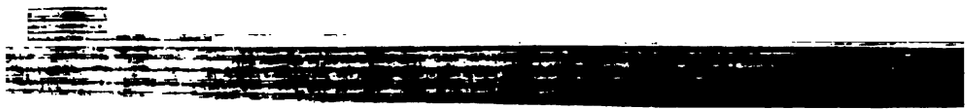


PLATE CXXXIII





with the facial artery at these points, but elsewhere above and external to it. The artery is crossed by filaments of the facial nerve, while the levator labii superioris muscle separates it from the infra-orbital nerve behind.

Branches of the Facial Portion of the Facial Artery.—These are the muscular, inferior labial, inferior coronary, superior coronary, lateralis nasi, and angular.

The **muscular branches** are directed outward to supply the buccinator, masseter, and internal pterygoid muscles. They anastomose with the masseteric and buccal branches of the internal maxillary and with the infra-orbital and transverse facial arteries.

The **inferior labial artery** passes inward beneath the depressor anguli oris to supply the muscles and integument of the lower lip and chin. It anastomoses with the inferior coronary, the submental branch of the facial, and the mental branch of the inferior dental artery.

The **inferior coronary artery** arises, either independently or in common with the inferior labial, from the facial artery near the angle of the mouth. It passes forward and inward in a tortuous manner beneath the depressor anguli oris toward the angle of the mouth, then pierces the orbicularis oris, and continues between it and the mucous membrane along the free margin of the lower lip. It anastomoses with the inferior coronary artery of the opposite side, the inferior labial, and the mental branch of the inferior dental artery.

The **superior coronary artery,** which is larger and takes a more tortuous course than the inferior coronary, arises from the facial artery beneath the zygomaticus major muscle. It pierces the orbicularis oris, and runs between it and the mucous membrane along the free margin of the upper lip to anastomose with the artery of the opposite side. By the anastomosis of the superior and inferior coronary arteries with their fellows an arterial circle is formed, which surrounds the mouth and can be felt pulsating on the internal surface of the lips between one-fourth and one-half of an inch from the junction of the skin and the mucous membrane. A small branch to the ala nasi and numerous branches to the labial glands are given off from this circle.

The **artery of the septum of the nose** is a branch of the superior coronary. The twigs of this *arteria septum narium* are a common source of epistaxis (nose-bleed). The hemorrhage from the branches of this vessel is readily controlled by

Harelip.—In the operation for harelip the bleeding can be controlled by grasping the lip between the thumb and forefinger. In introducing the harelip pin or suture, it must be passed deep enough to go beneath the divided coronary artery. Harelip is a congenital deformity consisting of one or more fissures in the upper lip, the result of arrested development. It may be single or double, the fissure or fissures being to the side of the median line of the lip, corresponding to the line of union between the intermaxillary and the superior maxillary bone. In double harelip the intermaxillary bone is often displaced forward. Double harelip is frequently associated with cleft palate.

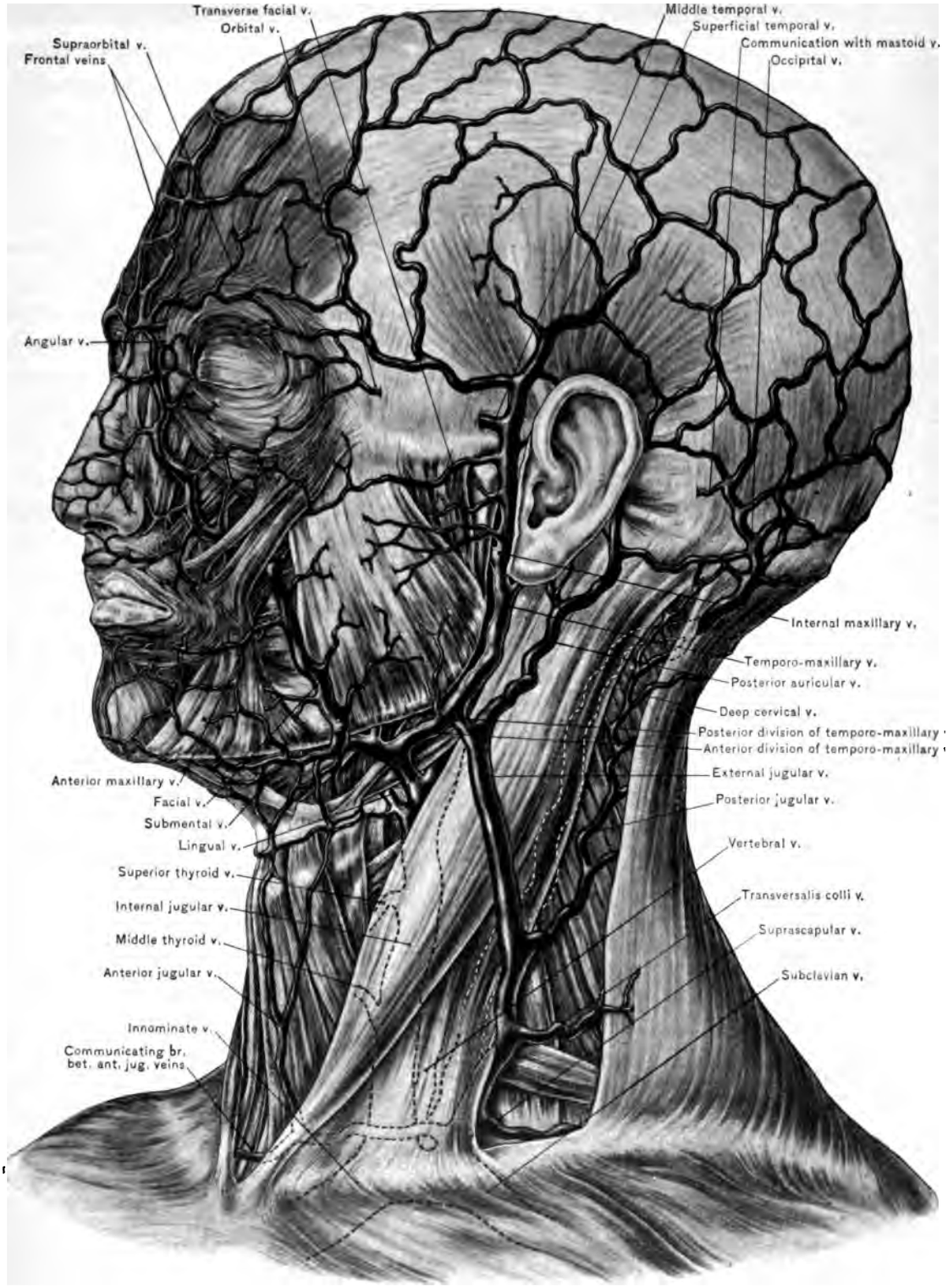
The **lateralis nasi artery** arises from the facial artery opposite the wing of the nose, and passes forward over the lower part of the nose and over the ala; it supplies the side and dorsum of the nose, and anastomoses with the lateralis nasi artery of the opposite side, the nasal branch of the ophthalmic, the infra-orbital, and the artery of the septum.

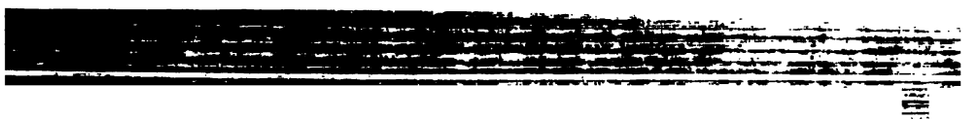
The **angular artery,** the terminal part of the facial, passes to the inner canthus of the eye, where it lies on the nasal side of the lacrymal sac and tendo oculi; it anastomoses with the nasal branch of the ophthalmic and with the infra-orbital artery, and supplies branches to the cheek. In opening an abscess of the lacrymal sac it is important to bear in mind the situation of this artery on the inner side of the sac.

Nervi molles.—The facial artery and its branches are surrounded by a minute plexus of sympathetic fibers (nervi molles) not demonstrable macroscopically. These fibers are branches of the superior cervical ganglion of the sympathetic, and supply the walls of the artery and its branches; they furnish the sympathetic root to the submaxillary ganglion.

Transverse facial artery.—Passing transversely across the face between the zygoma and the duct of the parotid gland, and resting upon the masseter muscle, is the transverse facial artery, which arises from the temporal artery in the substance of the parotid gland. It supplies the small, often detached, part of the parotid gland (the socia parotidis) in relation with the duct, the masseter and orbicularis palpebrarum muscles, and the integument. It anastomoses with the

PLATE CXXXIV.





as already stated, runs in an almost straight line to the anterior inferior angle of the masseter muscle, where it comes into relation with the outer side of the facial artery. In its course across the face it lies above and to the outer side of the artery, passing over the levator labii superioris, beneath the zygomatic muscles, and over the parotid duct, the buccinator muscle, the anterior inferior angle of the masseter muscle and masseteric fascia, and the body of the lower jaw. Below the jaw it is joined by the anterior branch of the temporo-maxillary vein, and empties into the internal jugular vein. It receives veins from the lower eyelid (the inferior palpebral), from the side of the nose (the lateral nasal), from the orbital vein, and, beneath the zygomaticus major muscle, a branch (deep facial) from the pterygoid plexus, besides muscular branches and branches corresponding to those of the facial artery. The facial vein—through the angular, in which it commences—communicates freely with the ophthalmic vein, and thus with the cavernous sinus; and it also communicates with the cavernous sinus, through the deep facial vein with the pterygoid plexus of veins, which, in turn, communicates with the sinus by means of small veins which pass through the foramen ovale, the foramen of Vesalius, and the middle lacerated foramen. Owing to the free communication between the vein and the cavernous sinus, the latter is endangered by any inflammatory condition of the facial vein.

Disease involving the facial vein.—The facial vein, as a rule, has no valves; it will therefore be understood how emboli are readily carried to the internal jugular vein and thus into the general circulation. Carbuncle of the face may prove fatal by inducing thrombosis of the cerebral sinuses through the communications previously described. Any deep inflammation of the face, as phlegmonous erysipelas, may be complicated by thrombosis or pyemia. The injection of facial nevi in infants may result in death from thrombosis, owing to the direct communication of the facial with the internal jugular vein. Pulmonary embolism and death have followed the injection of perchlorid of iron for nevoid growths of the face. In arterio-venous aneurysm of the cavernous sinus arterial blood, through the ophthalmic and angular veins, flows through the facial vein and gives rise to a pulsating varicose condition of the latter vein and a distinct thrill and bruit.

Vascularity of the face.—It has been demonstrated that the tissues of the

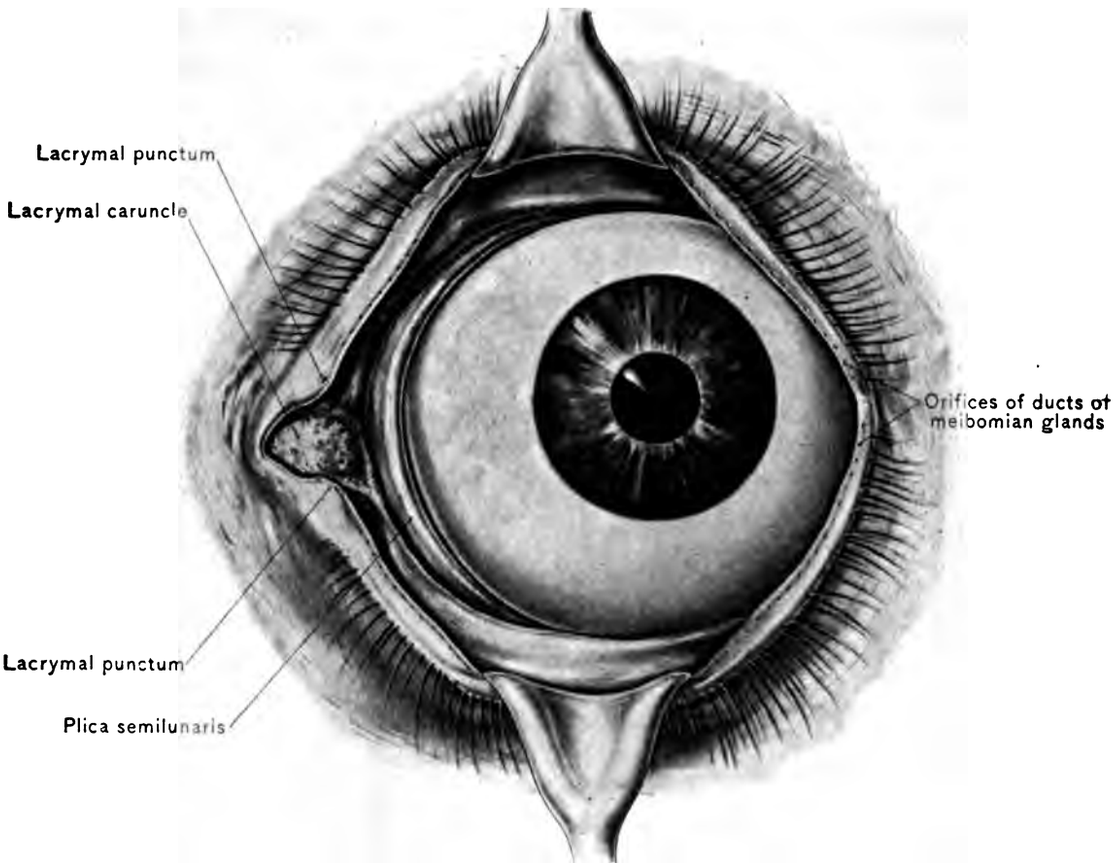
skin which have been torn up in lacerated wounds of the face often retain their vitality in almost as marked a manner as similar flaps torn from the scalp" (Treves). The anastomoses of the facial artery are so free that when the vessel is divided, both ends bleed freely and, according to the general rule, they should both be tied.

Dissection.—Upon the side of the face on which the muscles have been exposed the appendages of the eye,—including the eyelids, eyebrows, eyelashes, tarsal cartilages, conjunctiva, and lacrymal caruncle,—the parotid gland, and the external ear should be carefully dissected before turning the head to make the dissection of the nerves.

The **eyebrow** is a prominent arch of integument connected with the orbicularis palpebrarum, corrugator supercilii, and occipito-frontalis muscles. It is covered by numerous short, thick hairs which surmount the upper circumference of the orbit, their general direction being outward, though they interlace, the upper ones curving downward and the lower ones upward. They serve the twofold purpose of acting as a shield against the admission of foreign bodies to the eye, and as a multiple spring buffer reducing somewhat the impact of blows against the brow, thus often preventing serious wounds of the skin from traumatism applied against the sharp supra-orbital margin.

The **eyelids** (palpebræ) are two movable semilunar curtains placed in front of each eyeball to protect that exceedingly delicate and important organ. Their free edges are transverse and are studded with hairs, called eyelashes. The upper lid is the longer, so that when the lids are closed, their margin of contact lies below the center of the eye. The upper lid is also more freely movable; it has a special muscle to raise it—the levator palpebræ superioris. The interval between the open eyelids is called the *fissura palpebrarum*, or interpalpebral slit. At the points of union of the eyelids are the *external and internal canthi*, or palpebral commissures. The internal canthus is the larger; within it is a triangular space containing a depression, the *lacus lachrymalis*, and an elevation, the *caruncula lachrymalis*. At their free margins, which are concave, the lids are thickest. At their inner extremities and upon their free surfaces are two small eleva-

PLATE CXX

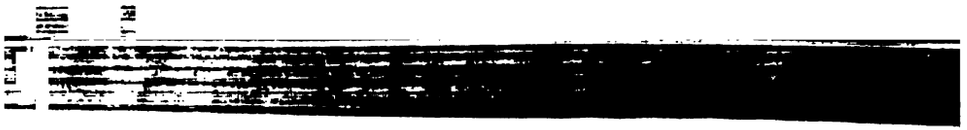

Lacrymal punctum
Lacrymal caruncle
Orifices of ducts of meibomian glands
Lacrymal punctum
Plica semilunaris

margin of the eyelid, which usually affects those on the anterior border, constitutes a stye.

The **eyelashes** (cilia) are two or more rows of short, thick, curved hairs, fixed in the anterior margin of the free border of the eyelids. They are longer and more numerous in the upper lid, and have their convexities directed downward, while those of the lower lid have their convexities directed upward. They protect the eye against the admission of dust and other foreign substances, especially during high winds.

The conjunctiva.—Before dissecting the eyelid, the conjunctiva and the lacrymal caruncle should be examined. The conjunctiva is the mucous membrane which covers the inner surface of the eyelids and the anterior part of the eyeball. At the free margin of the lids it is continuous with the integument. The part covering the eyeball is in relation with the sclerotic and the cornea. The conjunctiva consists of four divisions: the *palpebral*, the portion in relation with the eyelids; the *reflected*, the portion between the eyelids and the eyeball; the *sclerotic*, and the *corneal* portions. The lacrymal ducts (excretory ducts of the lacrymal gland) empty upon the free surface of the reflected portion of the conjunctiva. The palpebral portion is more vascular than the remaining parts, and is studded with a number of small papillæ, which, when enlarged by inflammation, constitute the disease known as granular lids, though this condition is at times also due to true granulations, which have a similar origin. The conjunctiva covering the sclerotic is loosely attached, and that covering the cornea is very thin, consisting merely of an epithelial layer which is very adherent. In congestion of the conjunctiva with effusion into the loose subconjunctival tissue (chemosis) the membrane is at times swollen to the very edge of the cornea, where it then forms a sharp elevated margin.

The **caruncula lachrymalis** is a small, reddish elevation situated at the inner canthus in the lacus lachrymalis. It consists of a separated portion of skin, which presents minute hairs upon its surface. It contains connective tissue, a small number of plain and striated muscular fibers and modified sweat glands, as well as a few sebaceous glands. External to the caruncle, and resting upon the eyeball, is a vertical triangular fold of conjunctiva, with its free concave margin directed toward the cornea; this is called the *plica semilunaris*, and is a rudimentary mem-



the lids behind the lashes. Each gland consists of a straight tube with many short, blind, diverticula. The Meibomian glands secrete a sebaceous material which prevents the lids from adhering, and are readily distinguished as closely adjacent, vertical, parallel, yellow streaks across the inner surface of the lids. When the duct of one of these glands becomes occluded, a retention cyst, similar to a wen, is formed.

Non-striated muscular fibers are found in both lids. In the upper lid these fibers originate from the lower surface of the levator palpebræ superioris; in the lower lid they arise from the vicinity of the inferior oblique muscle. In both lids they are inserted close to the attached border of the tarsal cartilage. They are known as the superior and inferior palpebral muscles of Müller.

Blood Supply.—The eyelids receive their blood supply from the palpebral and lacrymal branches of the ophthalmic artery and from small branches of the temporal and transverse facial arteries. The palpebral branches of the ophthalmic, two in number, arise from that artery near the pulley of the superior oblique muscle; one is found in each lid and runs through the fibrous tissue layer of the lids between the orbicularis palpebrarum muscle and the tarsal cartilages near their margins. The lacrymal is the first branch of the ophthalmic artery. It accompanies the lacrymal nerve and gives off palpebral twigs which anastomose with the other palpebral arteries to form the tarsal arches.

The *veins of the eyelids* are larger than the arteries, and outnumber them. They empty into the frontal and angular veins at the inner canthus, and into the orbital vein at the outer canthus. Some of the veins of the lids pass between and through the bundles of fibers of the orbicularis palpebrarum, and hence in many

in a broad, thin aponeurosis which is inserted into the upper border of the superior tarsal cartilage. This muscle runs above the superior rectus, and its upper surface is in relation with the frontal nerve and the supra-orbital artery.

The **parotid gland,** the largest of the salivary glands, weighs from one-half to one ounce. It is situated on the side of the face, and extends as high as the zygoma and below the level of the angle of the lower jaw. It covers about one-third of the masseter muscle, and extends backward to the external auditory meatus, the mastoid process, and the sterno-mastoid muscle. It is lodged in the space between the ramus of the lower jaw and the mastoid process. This space—known also as the bed of the parotid gland—can be increased in size by extending, and diminished by flexing, the head. With the mouth wide open—in which position the angle of the jaw is carried backward and the condyle forward—the width of the space is diminished below, but increased above. The size of the space is influenced by the age of the individual. In the infant, owing to the obliquity of the ramus and the absence of the angle of the lower jaw, it is broader, in proportion, below. In advanced age, when the teeth have fallen out, thus allowing the angle of the lower jaw to project forward, the space is broader below. When operating in this space these facts should be kept in mind, as it may be necessary to take advantage of them. The gland has three large processes or lobes: one, the *glenoid lobe*, extends upward into the posterior part of the glenoid cavity of the temporal bone which it occupies; another, the *pterygoid lobe*, extends forward beneath the ramus of the lower jaw, between the external and internal pterygoid muscles; the third process, the *carotid lobe*, passes behind the styloid process and beneath the mastoid process and the sterno-mastoid muscle, coming in contact with the internal jugular vein and the internal carotid artery. From the relation which the carotid lobe holds to the internal jugular vein, it follows that swelling of the gland, as in mumps, may cause passive congestion of the brain by compression of that vein. The anterior margin of the parotid gland overlaps the masseter muscle, and a detached portion of the gland (*socia parotidis*) lies over that muscle in relation with the upper border of Stenson's duct. From the position which the parotid gland holds with reference to the temporo-maxillary articulation it follows that, in inflammation of the gland, movement of the articulation is attended by pain; the extent to which the lower jaw can be

The deep fascia of the neck also sends beneath the gland a process continuous with the stylo-maxillary ligament, which separates the parotid from the submaxillary gland. The fibrous envelop of the parotid gland is incomplete above and in front, where its cavity is in communication with the pterygo-maxillary region. In parotid abscess the pus may, on account of this gap in the fascial envelop, extend into the pterygo-maxillary region, and by way of the latter into the temporal fossa, or to the side of the pharynx, meeting with less resistance in taking either of these directions than in attempting to reach the surface. The abscess may, however, extend into the neck by ulcerating through the layer of fascia beneath the gland. Many cases of retro-pharyngeal abscess are attended by swelling in the parotid region. Retro-pharyngeal growths—as, for example, sarcomata, when they have attained any size—cause bulging of the parotid region; and, conversely, tumors of the parotid may bulge into the pharynx. The severe pain in a rapidly growing tumor or abscess of the gland is due to the density of the fascia covering it. This, too, makes it difficult to detect fluctuation early. It also explains why the pus in a parotid abscess is so slow to find its way to the surface, and why an early opening should be made. The intimate relation existing between the parotid gland, the external auditory meatus, and the temporo-maxillary articulation is to be borne in mind, as a parotid abscess may open into the meatus or cause involvement of the joint.

Purulent meningitis and thrombosis of the cranial sinuses may be caused when pus finds its way through the foramina at the base of the skull.

The **sensory nerves** supplying the parotid gland are the auriculo-temporal branch of the inferior maxillary nerve, the great auricular branch of the cervical plexus, the facial nerve, and branches from the carotid plexus of the sympathetic nerve. In painful affections of the gland the pain is apt to be referred to the areas of distribution of these nerves.

The parotid lymphatic glands.—Lying upon the surface of the parotid gland (in front of the cartilage of the ear, and close to the root of the zygoma) are one

maxillary arteries; the terminal part of the great auricular nerve; and one or two lymphatic glands. The posterior auricular branch of the external carotid artery and the transverse facial branch of the temporal artery arise in the substance of the gland.

The parotid gland is separated from the internal carotid artery, from the internal jugular vein, and from the pneumogastric, glosso-pharyngeal, and hypoglossal nerves by a thin layer of fascia; therefore in stab wounds of the parotid region involving one of the two carotid arteries it may be difficult, at first, to tell which of the two vessels has been wounded.

From an anatomic point of view it is difficult to see how complete removal of the parotid gland is possible, yet the operation has been done so many times by skilful surgeons that there is no question of its feasibility. Doubtless, as long ago suggested by Führer, when the gland becomes the site of a neoplasm it becomes more compact, its processes being rounded off, as it were, and lifted away from the surrounding structures.

Complete removal of the parotid gland results in paralysis of the muscles of expression, for it is impossible to avoid dividing the facial nerve. The author has seen a growth of the overlying lymphatic gland cause facial paralysis from pressure, and thus so closely simulate a parotid neoplasm as to be pronounced a tumor of the parotid gland; but upon the removal of the growth the parotid gland was seen to occupy the bottom of the wound, and to be in a very much atrophied condition.

Socia parotidis.—That portion of the parotid gland resting upon the masseter muscle above the parotid duct (Stenson's duct), and quite separate from the gland proper, is known as the socia parotidis. Its duct empties into Stenson's duct.

Stenson's duct.—Running about one finger's breadth below the zygoma, or in a line drawn from the lower margin of the concha to a point midway between the free margin of the upper lip and the ala of the nose, is the duct of the parotid (Stenson's duct). It is about two inches in length by one-eighth of an inch in diameter, being narrowest at its point of communication with the mouth. It lies between the transverse facial artery above and the buccal branch of the facial nerve below. The duct runs over the masseter muscle, turning abruptly inward at its anterior border, passes through the mass of fat overlying the buccinator muscle and beneath the facial vein, and pierces the buccinator muscle to open into the mouth opposite the crown of the second molar tooth of the upper jaw. The turn of the duct around the anterior border of the masseter muscle must be borne in mind when passing a probe into the duct from the mouth. In opening a parotid abscess the incision should be horizontal, and should be made below the line of the duct and in front of the posterior border of the ramus of the lower jaw. Failure to observe this caution may result in section of the duct, with

resulting fistula (salivary fistula). It is also advisable to take every precaution against cutting through the gland tissue in opening a parotid abscess, for these collections of pus, like those of the mammæ, generally affect the connective tissue of the gland and not its substance or parenchyma.

Stenson's duct may be divided into a masseteric and a buccal portion. The *masseteric portion* rests upon the masseter muscle and the *buccal part* extends from the anterior border of the masseter muscle to the termination of the duct in the mucous membrane of the cheek. Fistulæ of the masseteric part are closed with difficulty, whereas fistulæ of the buccal portion are remedied by making an opening from the duct into the mouth on the proximal side of the fistula. The author has successfully treated fistulæ of the buccal portion by exposing the duct through an incision in the cheek, dividing the duct at the proximal side of the fistula, freeing the duct from the surrounding tissues, and stitching the divided end to the margins of an opening made in the mucous membrane of the mouth.

DISSECTION.—Before turning over the head to make the dissection of the opposite side of the face, the parotid gland should be removed entire; this operation will convey an approximate idea of the difficulties which would attend the removal of the gland in the living subject. The masseter muscle should then be exposed and the external ear dissected. In exposing the parotid gland, its fascial covering is seen to be continuous anteriorly with the fascia covering the masseter muscle, and, therefore, the parotid and masseteric fasciæ are practically one. These fasciæ are derived from the superficial layer of the deep cervical fascia, which is continued upward over the body of the lower jaw and attached above to the zygoma. By displacing the parotid gland forward and removing the fascia covering that portion of the masseter muscle in advance of the gland, the muscle itself is exposed.

The **masseter,** the most superficial of the muscles of mastication, is of quadrate form, and arises as two portions—a large, tendinous, superficial layer, and a small, fleshy, deep layer. The superficial sheet arises from the anterior two-thirds of the lower border of the zygomatic arch and from the lower border of the malar bone; its fibers pass downward and backward to be inserted into the outer surface of the angle and lower portion of the ramus of the lower jaw. The deep sheet arises from the posterior third of the lower border and all of the inner surface of the zygoma; it passes downward and forward to be inserted into the upper half of the ramus and the outer surface of the coronoid process of the lower jaw. The posterior portion of the muscle is concealed by the parotid gland. In relation with the superficial surface of the muscle are the orbicularis palpebrarum, the

with its deep surface are the buccal pad of fat, the buccinator and a small part of the temporal muscle, the masseteric artery and nerve, and the ramus of the jaw.

BLOOD SUPPLY.—From the masseteric branch of the internal maxillary, the transverse facial, and the facial artery.

NERVE SUPPLY.—From the masseteric nerve, a branch of the inferior maxillary division of the trifacial nerve.

ACTION.—It raises the lower jaw, as in mastication.

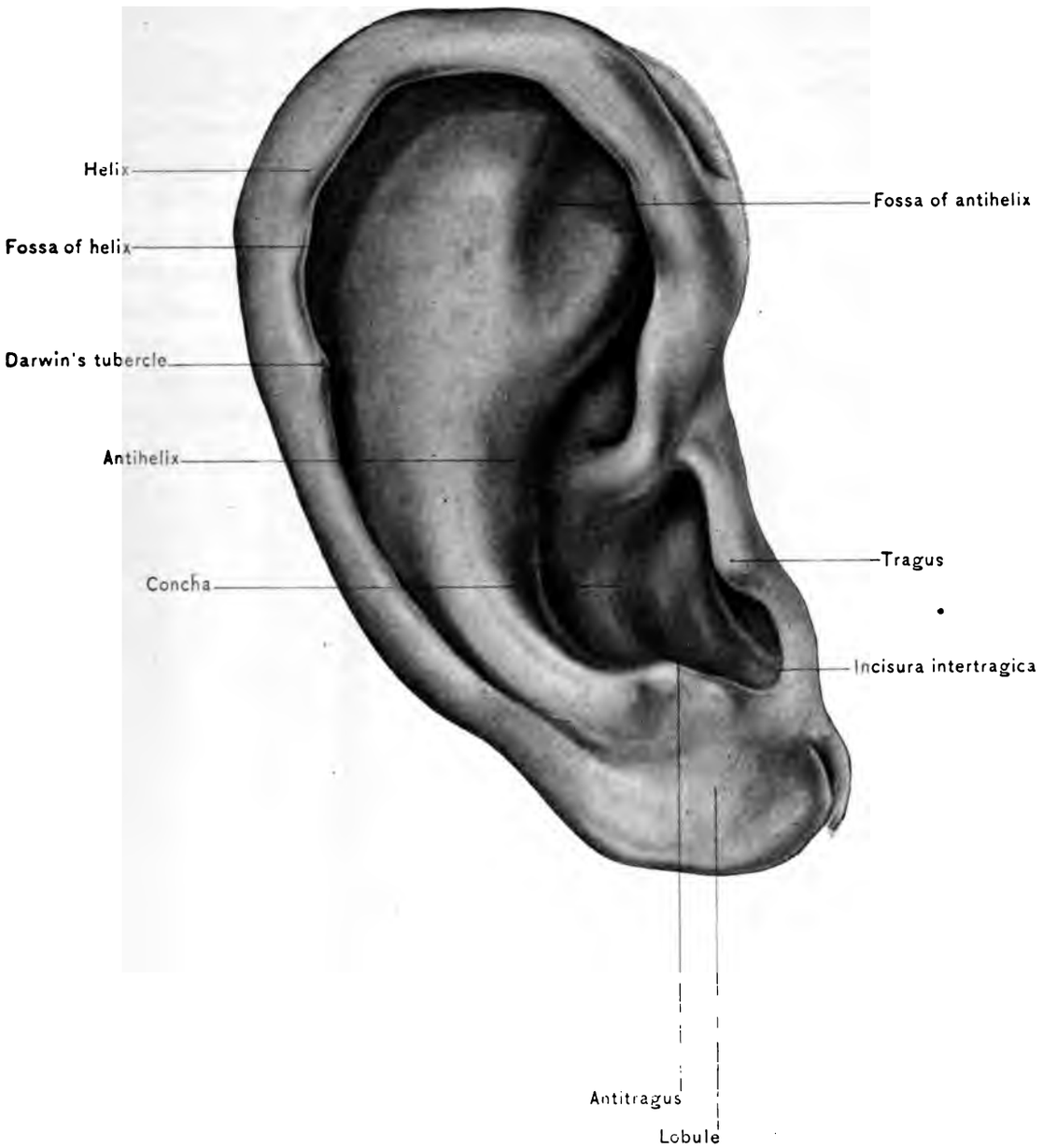
The **External Ear** consists of the pinna, or auricle, and of the tube leading to the tympanic membrane—the external auditory canal. The pinna collects the vibrations of sound, and the canal conveys them to the tympanum.

The **pinna, or auricle,** is pyriform in shape, with its concave surface directed outward and slightly forward, and consists of a layer of yellow fibro-cartilage having an uneven surface covered with integument. It is attached to the commencement of the external auditory meatus, and consists of various elevations and depressions, each elevation having a corresponding depression on its opposite surface. The deep hollow in its center, which is wide above and narrow below, is called the *concha*. The concha leads to the commencement of the external auditory meatus, and is partly divided into two by the beginning of the helix. The *helix* passes upward, forms the rim of the pinna, and terminates behind in the *lobule*, which is the lowest portion of the auricle and consists of fatty and areolar tissue. Internal to the helix is the depression called the *fossa of the helix*, or *scaphoid fossa*. Internal to the fossa of the helix is the ridge bounding the concha behind and above. This ridge is called the *anthelix;* it begins above the lobule, at a small prominence, the *antitragus*, and bifurcates at the upper part of the auricle, embracing a small triangular depression—the *fossa of the anthelix*. In front of the concha and projecting backward over the orifice of the external auditory meatus is the *tragus*. Between the tragus and antitragus is a notch—the *incisura intertragica*.

DISSECTION.—The integument should be removed from the pinna, when the small and rudimentary muscles and the cartilage will be exposed.

The integument of the pinna is thin and delicate. It contains sebaceous glands which are largest in the concha, and here the ducts of the glands often

PLATE CXXXVI



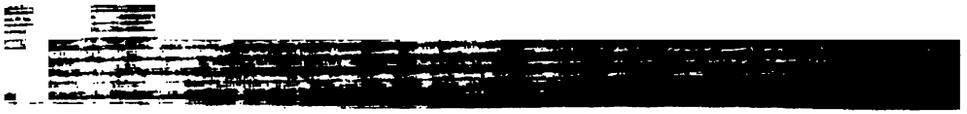
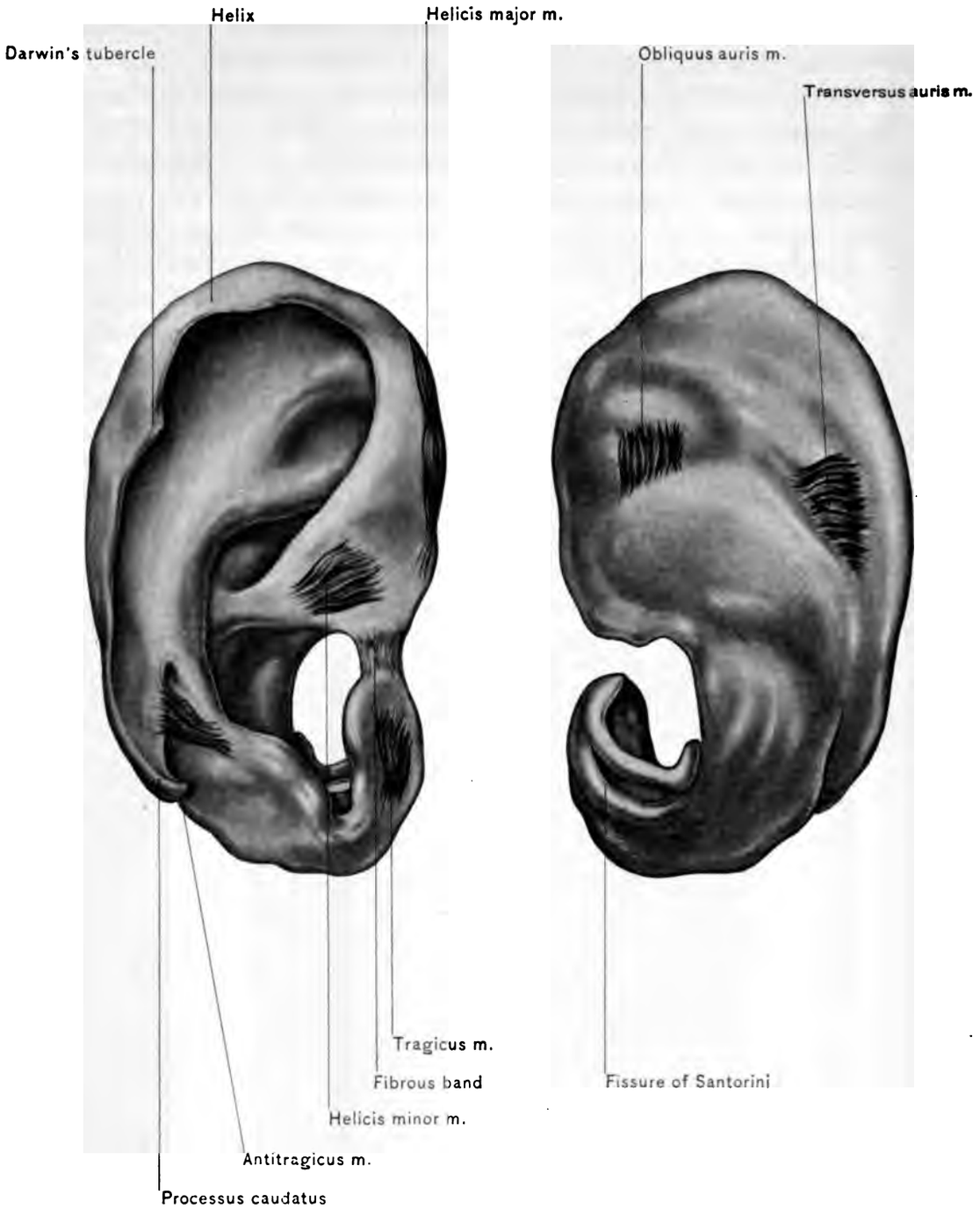
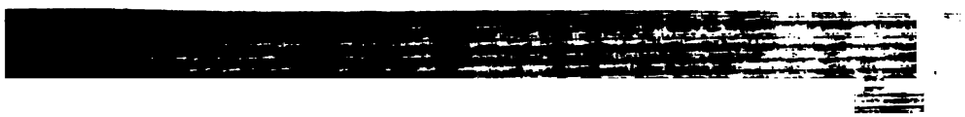


PLATE CXXXVII





Ludwig Meyer, degenerative changes in the blood-vessels and cartilage favor the occurrence of such extravasations. Cicatricial contractions may cause deformity of the pinna after the absorption or evacuation of such hematomata. Under the integument of the lobule gouty deposits (tophi) are sometimes found.

The **Muscles** which move the cartilage of the ear as a whole, three in number, have been described under the dissection of the scalp. The muscles proper of the auricle, which extend from one part of the cartilage to another, are six in number —namely, the muscle of the tragus, the muscle of the antitragus, the small muscle of the helix, the large muscle of the helix, the transverse muscle of the auricle, and the oblique muscle of the auricle.

The **tragicus,** the muscle of the tragus, is situated upon the outer surface of the tragus.

The **antitragicus,** the muscle of the antitragus, arises from the outer part of the antitragus; its fibers pass upward and are inserted into the posterior extremity of the helix.

The **helicis minor,** the small muscle of the helix, is attached to the commencement of the helix and extends into the concha. This muscle is sometimes absent.

The **helicis major,** the large muscle of the helix, is situated upon the anterior margin of the helix; it arises above the small muscle and is inserted into the front of the helix, where it begins to curve backward.

The **transversus auris,** the transverse muscle of the auricle, is situated on the back of the auricle in the depression between the helix and the convexity of the concha; it arises from the convexity of the concha and is inserted into the back of the helix.

The **obliquus auris,** the oblique muscle of the auricle, extends from the upper back part of the concha to the convexity immediately above it.

Nerve Supply.—The pinna derives its nerve supply from the auriculo-temporal, the posterior auricular, the auricular branch of the pneumogastric (Arnold's nerve), the occipitalis minor, and the auricularis magnus nerve.

Action.—The muscles of the helix assist those of the tragus and antitragus in retarding the passage of sound to the meatus.

Blood Supply.—The pinna is well supplied with freely anastomosing vessels—branches of the posterior auricular, temporal, and occipital arteries. The veins

which forms the outer part of the external auditory meatus; it is wanting between the tragus and the commencement of the helix, the interval between them being occupied by fibrous tissue. Where the helix makes its first bend, at the front part of the pinna, is a conic projection of the cartilage—the process of the helix. At the highest part of the helix there is not infrequently to be seen another conic projection, to which Darwin first called attention; he regards it as the representative of the extreme tip of the pinna of some of the lower animals. At certain places the cartilage is incomplete; these gaps are known as fissures, and are located as follows: at the anterior part of the pinna, behind the process of the helix (fissure of the helix); on the surface of the tragus; and at the lower part of the anthelix. In the piece of cartilage which forms the outer part of the meatus are two fissures—the *fissures of Santorini*. The pinna is attached anteriorly to the root of the zygoma and posteriorly to the mastoid process by bands of fibrous tissue; in addition, there are various intrinsic ligaments, uniting the different parts.

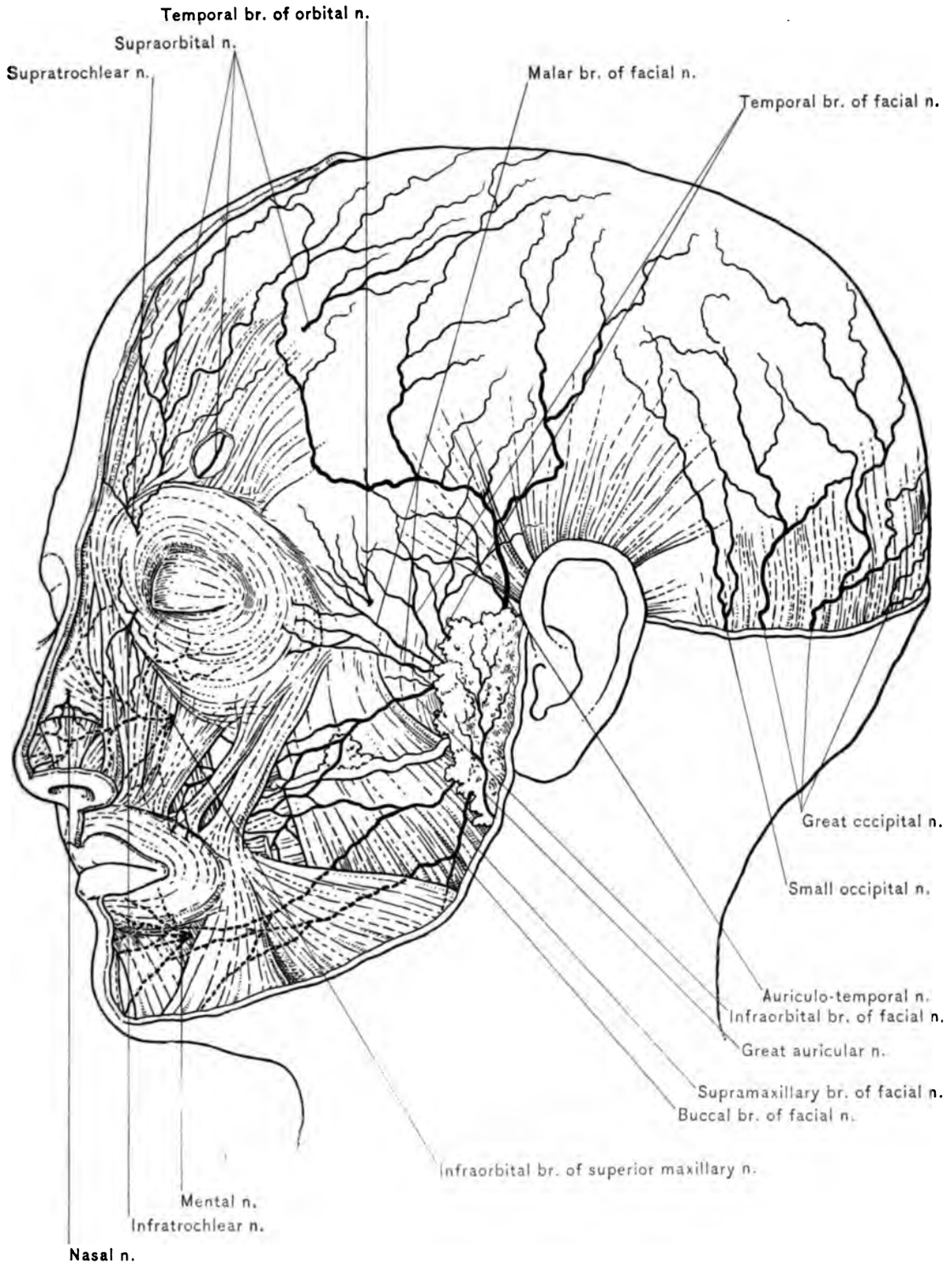
Dissection.—Turn the head to the opposite side, fix it with hooks, and work out the facial nerve and the branches of the trifacial nerve which make their exit upon the face. Expose the facial nerve by a longitudinal incision carried into the substance of the parotid gland in front of the lobe of the ear, cutting away a little of the gland with each movement of the knife until the nerve is seen, when it can be traced both backward and forward.

The **facial nerve** (the seventh cranial) is the motor nerve of the face; it consists of three portions—the intra-cranial, the temporal, and the facial. The facial portion, that which concerns us in this dissection, supplies all the muscles of expression and the platysma, the buccinator, the occipito-frontalis, the attrahens, attolens, and retrahens aurem, the posterior belly of the digastric, and the stylo-hyoid.

A line drawn from the anterior border of the mastoid process opposite the base of the lobule of the ear downward and forward across the face for about one inch will represent the course of the facial portion of the trunk of the nerve.

Course.—It leaves the cranial cavity through the internal auditory meatus in company with the auditory nerve, the pars intermedia of Wrisberg, and the auditory artery. Reaching the bottom of the internal auditory meatus it enters the facial canal, or aqueductus Fallopii of the temporal bone, from which it makes its exit by way of the stylo-mastoid foramen. Passing downward and forward from the foramen it enters the parotid gland, crosses the external carotid artery, gives off a posterior auricular, a digastric, and a stylo-hyoid branch, and terminates

PLATE CXXXIX.



auricular branch of the pneumogastric and the great auricular branch of the cervical plexus, and divides into an auricular and an occipital branch. The auricular branch supplies the attolens and retrahens aurem muscles. The occipital branch passes along the superior curved line of the occipital bone, supplies the occipitalis muscle, and communicates with the small occipital branch of the cervical plexus.

The **digastric branch** supplies the posterior belly of the digastric muscle, and communicates, by a twig which usually perforates that muscle, with the glosso-pharyngeal nerve.

The **stylo-hyoid branch** is longer than the digastric; it enters the stylo-hyoid muscle about its middle, and communicates with filaments of the sympathetic nerve on the external carotid artery.

The **temporo-facial,** the larger of the two terminal divisions, runs obliquely upward and forward through the substance of the parotid gland, crosses the external carotid artery and the temporo-maxillary vein, and breaks up into the temporal, malar, and infra-orbital branches. It communicates with the auriculo-temporal nerve. The *temporal branches* ascend obliquely over the zygomatic arch to supply the tensor tarsi, the orbicularis palpebrarum, the corrugator supercilii, the frontalis, and the attolens and attrahens aurem muscles, and to communicate with the supra-orbital, the lacrymal, and the auriculo-temporal nerve, and with the temporo-malar branch of the superior maxillary nerve.

The *malar branches* run across the malar bone to the outer angle of the orbit to supply the orbicularis palpebrarum muscle, and communicate with the lacrymal and the supra-orbital nerve and with the infra-orbital and temporo-malar branches of the superior maxillary nerve. The *infra-orbital*, the largest branch, gives off a superficial and a deep set of branches, which pass transversely forward over the masseter and beneath the zygomatic muscles to supply the zygomatic muscles, the elevators of the upper lip, the muscles of the nose, and the orbicularis oris muscle. The superficial branches communicate with the nasal and infra-trochlear nerves which are derived from the ophthalmic division of the trifacial nerve. The deep branches form a loop with the buccal branch of the cervico-facial division, and pass beneath the levator labii superioris muscle, where they unite with the infra-orbital branch of the superior maxillary nerve, forming the *infra-orbital plexus.*

The **cervico-facial,** the smaller of the two terminal divisions of the facial nerve, is joined by a branch of the great auricular nerve while in the substance of the parotid gland. It passes obliquely downward toward the angle of the lower jaw, crosses the external carotid artery and the temporo-maxillary vein, and divides

pass forward over the masseter and buccinator muscles below Stenson's duct, to the angle of the mouth, to supply the buccinator and orbicularis oris muscles, and communicate with the infra-orbital nerve, the infra-orbital branches of the temporo-facial branch, and the long buccal branch of the inferior maxillary nerve. The buccal branch of the facial nerve and the long buccal branch of the inferior maxillary nerve form a plexus over the buccinator muscle and the facial vein. The *supra-maxillary branch* passes downward and forward over the masseter muscle and the facial artery, and beneath the platysma myoides and the depressor muscles of the lower lip. It supplies the muscles of the lower lip, the risorius, and the levator menti, and communicates with the buccal branch of the facial and the mental branch of the inferior dental nerve. The *infra-maxillary branch* emerges from the lower border of the parotid gland in front of the external jugular vein and passes downward and forward toward the sternum beneath the platysma myoides muscle, which it supplies. It communicates with the great auricular and superficial cervical nerves—branches of the cervical plexus. The infra-maxillary branch can be traced when dissecting the superficial fascia of the neck.

The **pes anserinus** (plexus parotideus).—The breaking up of the two terminal divisions of the facial nerve within the substance of the parotid gland gives rise to a plexus, the pes anserinus (goose's foot).

Bell's palsy.—Paralysis of the facial nerve is known as Bell's palsy, and may be either central or peripheral. A central paralysis is due to involvement of the nucleus of the nerve, its center in the cortex of the brain, or the fibers connecting these, and results from pressure, as by hemorrhage, abscess, or tumor; it may also be brought about by degenerative processes in the brain. A peripheral paralysis is due to affection of the trunk of the nerve within the cranial cavity by tumors or meningitis; within the facial or Fallopian canal, by middle ear disease or frac-

PLATE CXL.

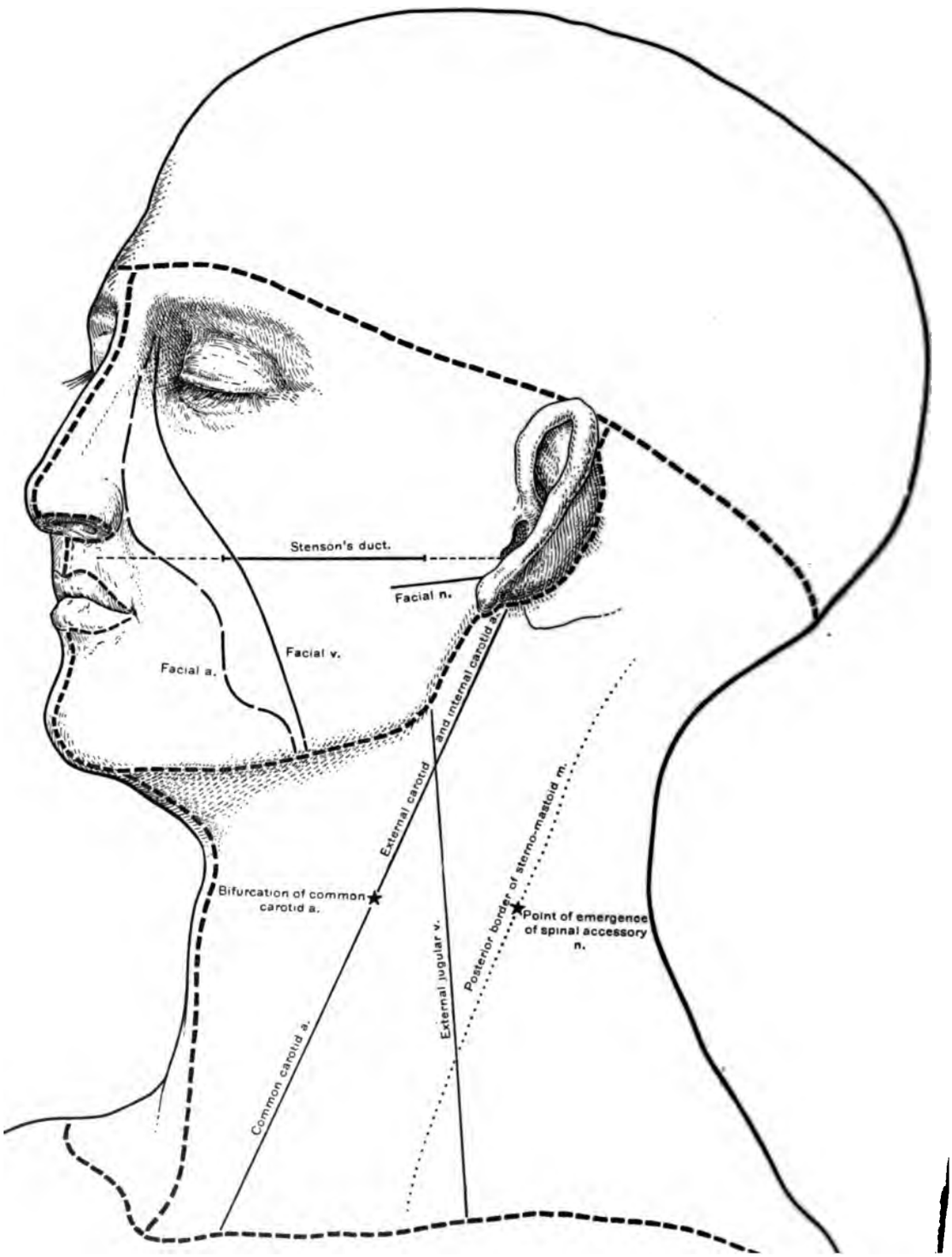
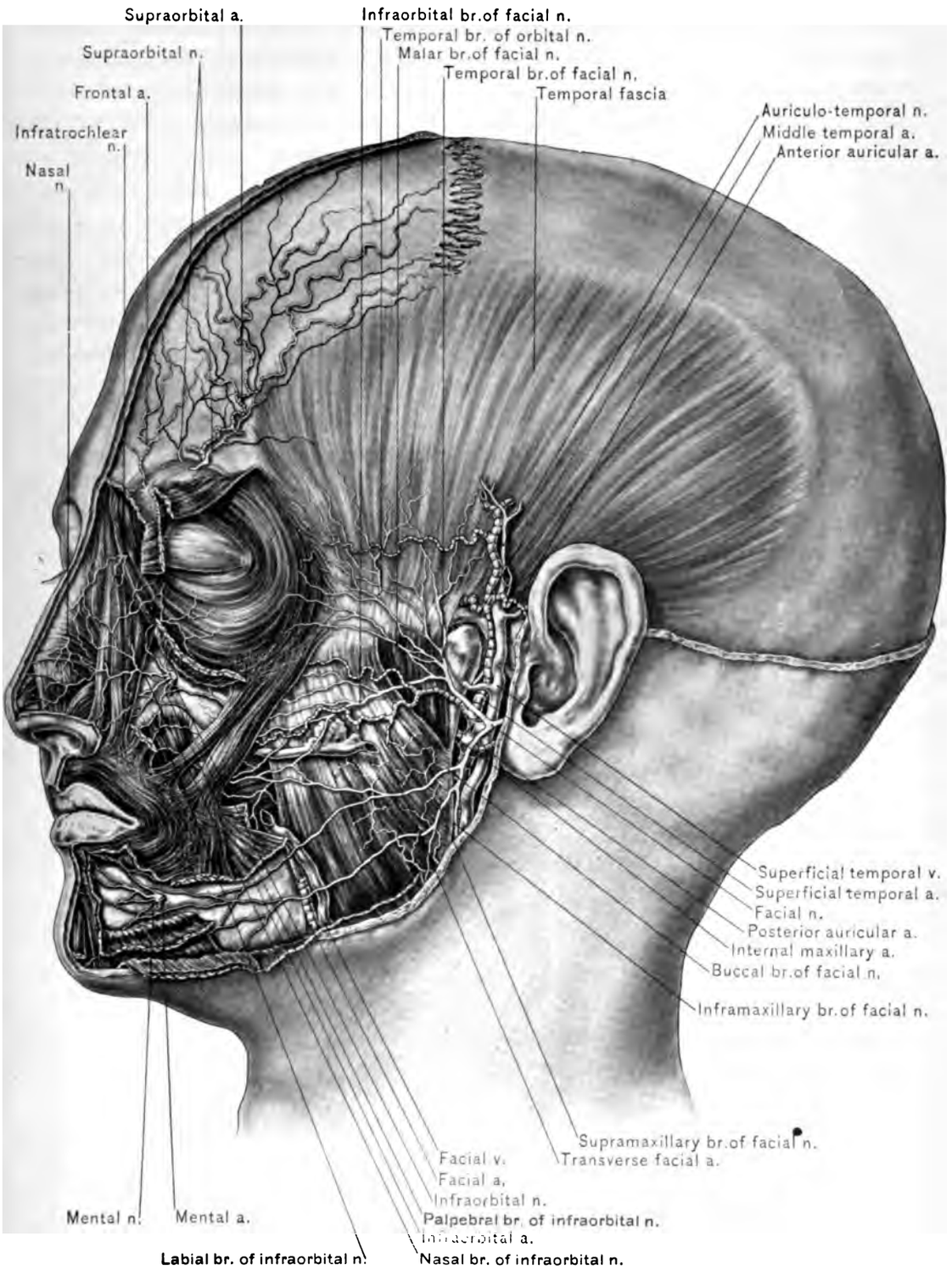

Stenson's duct.
Facial n.
Facial v.
Facial a.
External carotid and internal carotid a.
Bifurcation of common carotid a.
Posterior border of sterno-mastoid m.
Point of emergence of spinal accessory n.
External jugular v.
Common carotid a.

PLATE CXLI.


Supraorbital a.
Infraorbital br.of facial n.
Temporal br. of orbital n.
Supraorbital n.
Malar br.of facial n.
Temporal br.of facial n.
Frontal a.
Temporal fascia
Auriculo-temporal n.
Infratrochlear n.
Middle temporal a.
Anterior auricular a.
Nasal n.
Superficial temporal v.
Superficial temporal a.
Facial n.
Posterior auricular a.
Internal maxillary a.
Buccal br.of facial n.
Inframaxillary br.of facial n.
Supramaxillary br.of facial n.
Transverse facial a.
Facial v.
Facial a.
Infraorbital n.
Palpebral br. of infraorbital n.
Infraorbital a.
Mental n.
Mental a.
Labial br. of infraorbital n.
Nasal br. of infraorbital n.

and above the origin of the chorda tympani nerve, there is loss of the sense of taste in the anterior two-thirds of the tongue on the diseased side, and through paralysis of the stapedius muscle loud sounds are distressing. When the lesion is central or in the brain, the brow and eyelid are not affected—*i. e.*, the frontalis, corrugator supercilii, and orbicularis palpebrarum muscles are not involved. This is probably due to escape of the fibers which arise from the nucleus of the opposite side.

Spasms, both tonic and clonic, of the muscles supplied by the facial nerve may occur. Persistent spasm of these muscles is relieved by stretching the facial nerve.

Operative exposure of the facial nerve.—The facial nerve is exposed by carrying a vertical incision from in front of the mastoid process and behind the lobule of the ear downward toward the angle of the lower jaw, laying bare first the posterior border of the parotid gland, which is displaced forward, and then the anterior border of the sterno-mastoid muscle at its insertion. The parotid gland should be separated from the mastoid process to the depth of about one centimeter, when the nerve may be seen. The exact location of the nerve in the wound can be ascertained by the use of the faradic battery.

The trifacial nerve.—The branches of the trifacial or fifth nerve which make their exit upon the face are the supra-orbital and the supra-trochlear (previously described), the lacrymal, the infra-orbital, the malar, the anterior branch of the nasal, and the mental nerve.

The **lacrymal nerve,** the smallest of the ophthalmic branches, supplies the lacrymal gland, and frequently communicates with the temporal branch of the temporo-malar nerve in the orbit; it sends a small filament—the palpebral—to the skin and conjunctiva around the outer canthus of the eye.

The **infra-orbital nerve,** the terminal branch of the superior maxillary division of the trifacial nerve, emerges from the infra-orbital foramen in company with the infra-orbital artery, under cover of the levator labii superioris muscle. It immediately divides into palpebral, nasal, and labial branches. The *palpebral branches*, the smallest, pass upward beneath the orbicularis palpebrarum muscle, supply the lower eyelid, and communicate with the facial and the malar branch of the orbital or temporo-malar nerve. The *nasal branches*, three or four in number, pass inward under the levator labii superioris alæque nasi muscle to supply the side of the nose, and communicate with the external (naso-labial) branch of the nasal nerve. The *labial branches*, usually four, are larger than the palpebral or

The **infra-orbital artery,** a branch of the internal maxillary, accompanies the infra-orbital nerve through the infra-orbital foramen, and divides into branches which are distributed like those of the nerve. It anastomoses with the transverse facial, facial, and ophthalmic arteries.

The **infra-orbital vein** communicates with the facial vein in front, and empties into the pterygoid plexus of veins.

The **malar division** of the orbital or temporo-malar branch of the superior maxillary nerve makes its exit through a foramen in the malar bone, pierces the orbicularis palpebrarum muscle, and supplies the skin of the cheek covering the malar bone. It communicates with the facial and the palpebral branches of the infra-orbital nerve.

The **external or terminal branch of the nasal nerve,** also known as the naso-labial, emerges between the nasal bone and the lateral cartilages of the nose, supplying the tip of the nose as it descends beneath the compressor narium muscle. It communicates with the infra-orbital branches of the facial and trifacial nerves.

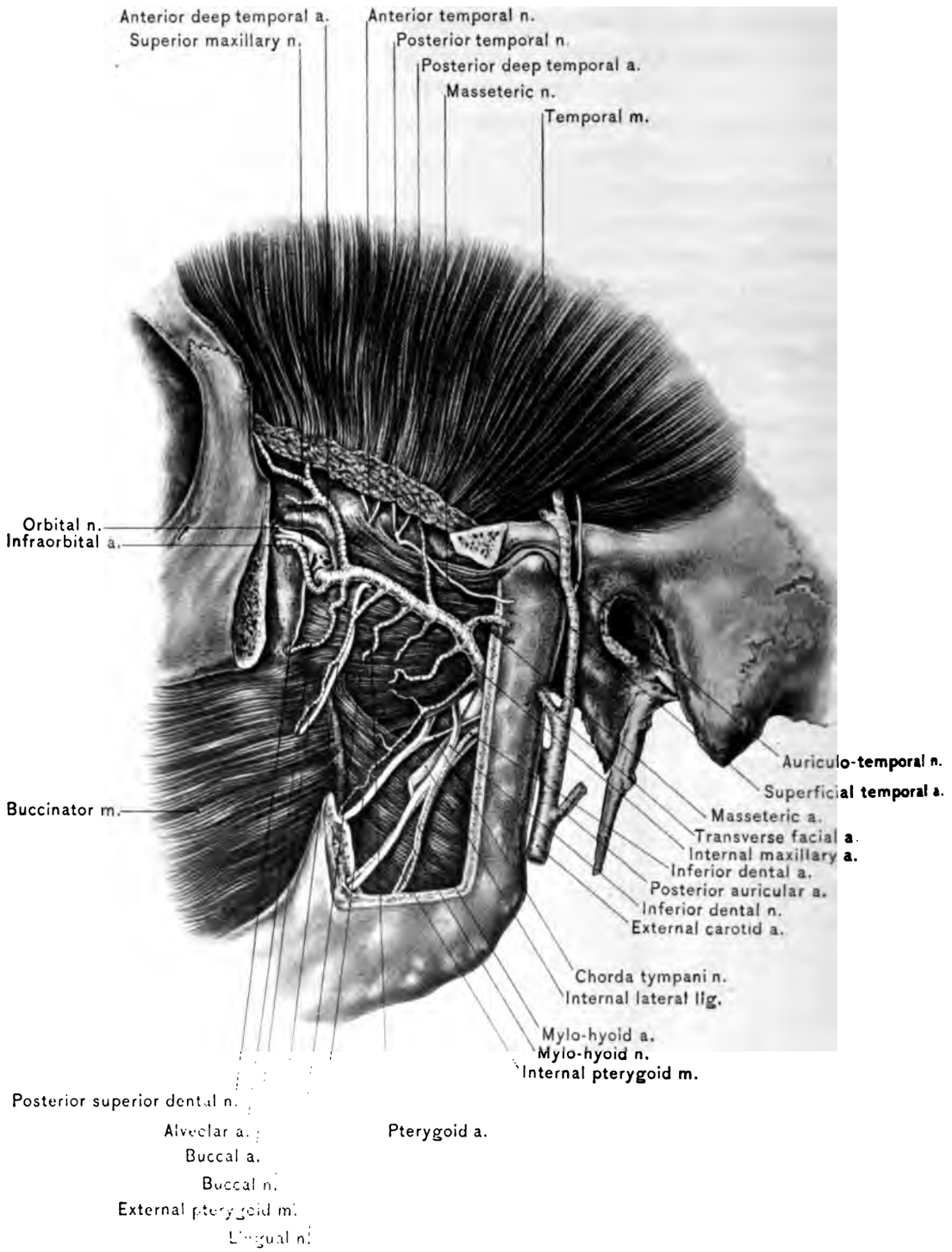
The **mental nerve,** the continuation of the inferior dental, emerges from the mental foramen in company with the mental artery. It divides beneath the depressor anguli oris muscle into three branches, the smallest of which descends to supply the chin, while the other two ascend to supply the lower lip. It inosculates with the supra-maxillary branch of the facial nerve.

The **mental artery,** the terminal portion of the inferior dental, supplies the chin and anastomoses with the submental, inferior labial, and inferior coronary arteries.

PTERYGO-MAXILLARY REGION.

The pterygo-maxillary region is the space included between the ramus of the lower jaw, externally; the lateral wall of the pharynx and the pterygoid process of the sphenoid bone, internally; the zygomatic surface of the superior maxilla, anteriorly; and the lower surface of the greater wing of the sphenoid and the adjacent temporal bone, above. The posterior limit of the space is represented by a plane passing directly inward from the posterior border of the ramus of

PLATE CXLII.


Anterior deep temporal a.
Superior maxillary n.
Anterior temporal n.
Posterior temporal n.
Posterior deep temporal a.
Masseteric n.
Temporal m.
Orbital n.
Infraorbital a.
Buccinator m.
Auriculo-temporal n.
Superficial temporal a.
Masseteric a.
Transverse facial a.
Internal maxillary a.
Inferior dental a.
Posterior auricular a.
Inferior dental n.
External carotid a.
Chorda tympani n.
Internal lateral llg.
Mylo-hyoid a.
Mylo-hyoid n.
Internal pterygoid m.
Posterior superior dental n.
Alveolar a.
Buccal a.
Buccal n.
External pterygoid m.
Lingual n.
Pterygoid a.

removed in the following manner: With Hey's saw cut downward behind the last molar tooth, half way through the body of the jaw, then backward to near the angle. Discard the saw when it reaches the cancellous tissue, and use the chisel to avoid division of the inferior dental vessels and nerve. The saw should now be directed downward from the sigmoid notch, just in front of the neck of the jaw, through the ramus to the end of the incision in the body of the bone. The removal of this portion of the inferior maxilla is tedious, as the internal pterygoid muscle, internal lateral ligament, and the inferior dental vessels and nerve oppose elevation of the section of bone thus separated. Remove the posterior inferior corner of the section of the ramus with bone forceps as far as the inferior dental canal, which contains the inferior dental vessels and nerve; then reflect the bone with the lower portion of the temporal muscle, taking care to avoid destroying the mylo-hyoid artery and nerve which arise from the inferior dental artery and nerve, near the inferior dental foramen, and pass downward and forward in a groove on the internal surface of the ramus. In making this dissection it is advisable to use the back of the point of the scalpel, as the vessels and nerves are small, of delicate structure, and are easily severed.

The **contents of the pterygo-maxillary region** are the internal and external pterygoid muscles, the internal maxillary artery with some of its branches and their companion veins, the pterygoid plexus of veins, the inferior maxillary nerve, and the following branches of that nerve: The anterior and posterior deep temporal, long buccal, masseteric, internal and external pterygoid, inferior dental, auriculo-temporal, and lingual nerves, the chorda tympani nerve, a portion of the parotid gland, the internal lateral ligament of the lower jaw, and the internal maxillary lymphatic glands.

The **internal maxillary artery,** which is closely related to the nerves of this region, passes forward either over or behind the external pterygoid muscle.

The **internal lateral ligament** is a thin, fibrous band which lies beneath the inferior dental vessels and nerve; it passes, with the lingual and inferior dental nerves, through the triangular interval between the two pterygoid muscles and the incised edge of the jaw.

The **external pterygoid muscle,** the more superficial of the two pterygoids, arises by an upper head from that portion of the greater wing of the sphenoid bone situated between the pterygoid ridge and the foramina ovale and spinosum;

It is related, externally, with the ramus of the inferior maxilla, the temporal and masseter muscles, the superficial portion of the internal pterygoid muscle, the internal maxillary artery, the anterior and posterior deep temporal arteries, and the buccal artery and nerve. Internally, it is in relation with the deep part of the internal pterygoid muscle, the middle meningeal artery, and the inferior maxillary nerve, the internal lateral ligament of the lower jaw, the lingual and inferior dental nerves, which emerge from beneath its lower border; the long buccal nerve, which runs between its two heads; the chorda tympani nerve, and the anterior and posterior deep temporal and masseteric nerves, which pass out from beneath the upper border of the muscle.

Blood Supply.—From the external pterygoid branches of the internal maxillary artery.

Nerve Supply.—From the inferior maxillary nerve.

Action.—The external pterygoid muscles acting together pull the lower jaw forward; alternately, they move it forward and laterally; and, singly, forward and to the opposite side. They are muscles of trituration.

The **internal pterygoid muscle** (the internal masseter) arises by two heads, a superficial and a deep. The superficial, the smaller, arises from the lower and back part of the tuberosity of the upper jaw, and the outer side of the tuberosity of the palate bone. The deep lies behind the lower head of the external pterygoid and arises from the internal surface of the external pterygoid plate, and from the grooved portion of the tuberosity of the palate bone situated in the pterygoid fossa. These two heads unite at the lower margin of the external pterygoid muscle, and thence extend downward, backward, and outward for insertion into the rough inner surface of the posterior portion of the ramus of the lower jaw included between the angle and the inferior dental foramen.

It is related, externally, with the ramus of the lower jaw, the external pterygoid muscle, the internal lateral ligament of the lower jaw, the lingual or gustatory nerve, and inferior dental and mylo-hyoid vessels and nerves; internally, with the tensor palati, stylo-glossus, stylo-hyoid, posterior belly of the digastric, and the superior constrictor muscle of the pharynx.

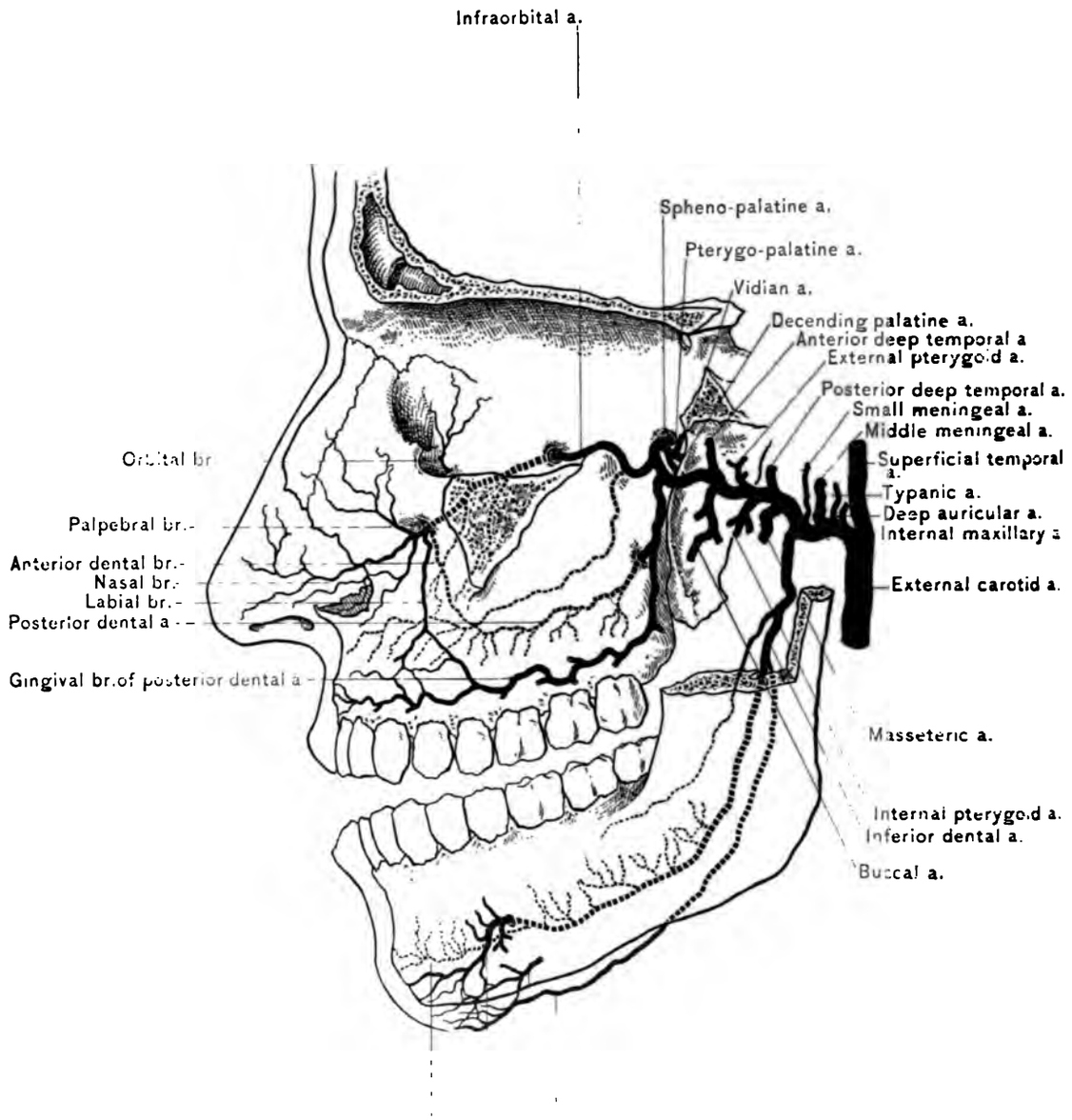
Blood Supply.—From the mylo-hyoid and internal pterygoid branches of the internal maxillary artery.

Nerve Supply.—From the internal pterygoid branch of the inferior maxillary nerve.

Action.—Both internal pterygoid muscles acting together draw the lower jaw upward and forward; and, singly, upward and to the opposite side.

The **internal maxillary artery,** the larger of the two terminal branches of the external carotid, arises in the parotid gland, opposite to or slightly lower than

PLATE CXLIII.



the neck of the lower jaw. The artery is divided into three portions: maxillary, pterygoid, and spheno-maxillary. The *first or maxillary portion* passes forward between the internal lateral ligament and the neck of the lower jaw, and reaches the lower margin of the external pterygoid muscle. The *second or pterygoid portion* extends obliquely upward and forward upon the outer surface of the external pterygoid muscle, and is hidden by the insertion of the temporal muscle. The *third or spheno-maxillary portion* lies in the spheno-maxillary fossa. In some instances the second or pterygoid portion runs entirely beneath the external pterygoid muscle, but, by passing between the two heads of that muscle, appears upon the outer surface of the muscle just before entering the spheno-maxillary fossa.

The *branches of the first or maxillary portion of the internal maxillary artery* are: The deep auricular, tympanic, middle meningeal, small meningeal, and inferior dental arteries.

The *deep auricular artery* pierces the wall of the external auditory canal to supply the tympanic membrane.

The *tympanic artery* passes behind the temporo-maxillary joint through the Glaserian fissure to supply the tympanum.

The *middle meningeal artery* runs upward between the two roots of the auriculo-temporal nerve to the foramen spinosum, through which it enters the cranial cavity to supply the cranium and dura mater.

The *small meningeal artery* ascends to the foramen ovale, through which, after supplying a twig to the nasal fossa and soft palate, it enters the cranial cavity.

The *inferior dental artery*, with its venæ comites, accompanies the inferior dental nerve and passes downward, upon the internal pterygoid muscle and the internal lateral ligament, entering the inferior dental foramen together with the inferior dental nerve. The artery then occupies the inferior dental canal, distributing branches to the teeth; it supplies an incisive branch, and emerges, on the face, from the mental foramen; it is then called the *mental artery;* the mental artery is accompanied by the mental nerve, and is distributed to the structures of the chin and lower lip. Before entering the inferior dental canal

The *pterygoid arteries*, varying in number, supply the external and internal pterygoid muscles.

The *masseteric artery*, with the masseteric nerve, passes outward behind the temporal muscle through the sigmoid notch of the lower jaw to the masseter muscle.

The *buccal artery* accompanies the long buccal nerve in its forward course between the ramus of the lower jaw and the external pterygoid to the buccinator muscle.

The *branches of the third or spheno-maxillary portion* are the alveolar, infra-orbital, posterior or descending palatine, Vidian, pterygo-palatine, and naso-palatine or spheno-palatine arteries.

The *alveolar* (*posterior superior dental or posterior dental*) *artery* gives off branches to the gums and the buccinator muscle, enters the superior maxilla at its zygomatic surface, and supplies the molar and bicuspid teeth and the mucous lining of the maxillary sinus or antrum of Highmore.

The *infra-orbital artery* immediately enters the infra-orbital groove and canal, accompanied by the superior maxillary division of the fifth pair of cranial nerves, and eventually emerges upon the face in company with the infra-orbital nerve at the infra-orbital foramen. It supplies branches to the orbit, and gives off an *anterior superior dental branch*, which runs downward in the anterior wall of the maxillary sinus and supplies the incisor and bicuspid teeth and the mucous membrane of the maxillary sinus.

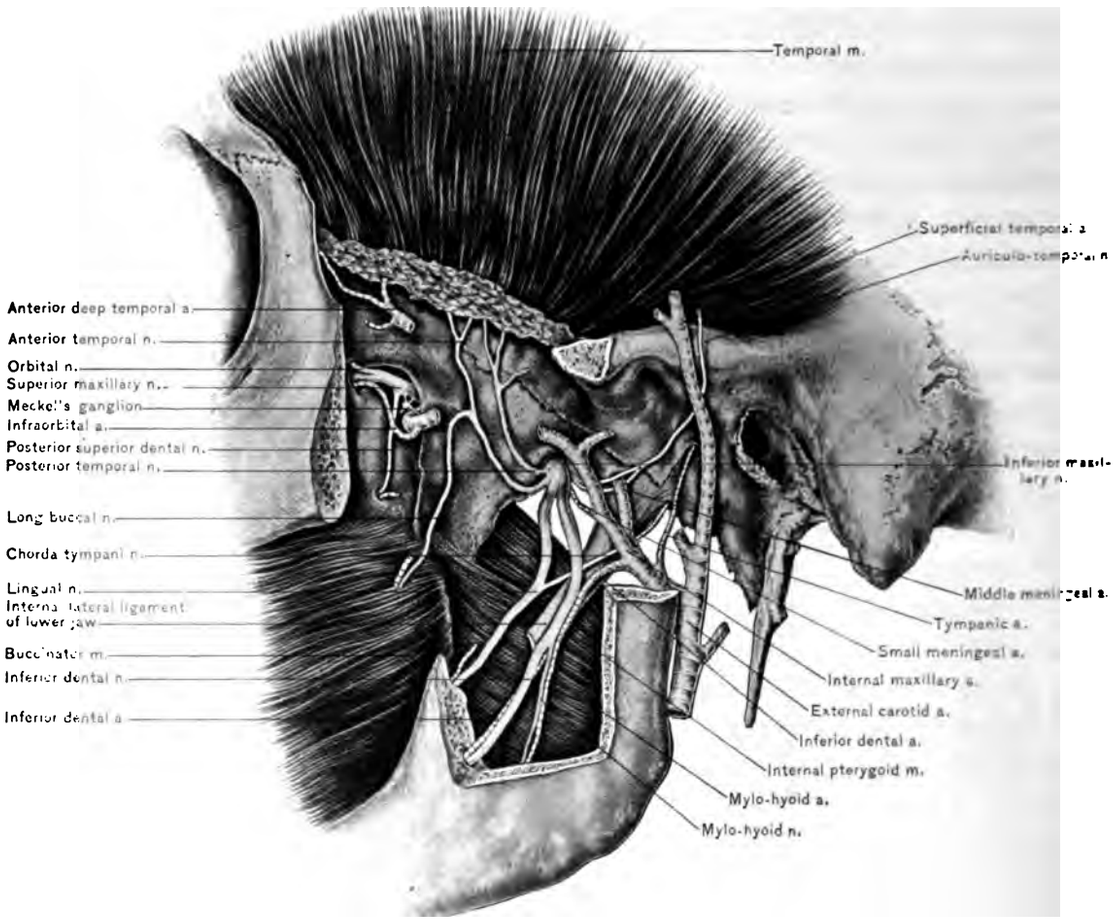
The *posterior or descending palatine artery* accompanies the posterior palatine branches of Meckel's or the spheno-palatine ganglion of the fifth pair of cranial nerves, through the posterior palatine canal, then emerges from the posterior palatine foramen, and passes forward in a groove situated near the alveolar process along the under surface of the hard palate; it next enters the foramen of Stenson, a subdivision of the anterior palatine foramen, and anastomoses with the naso-palatine artery. It is distributed to the hard and soft palate, palatine glands, and gums.

The *Vidian artery* runs backward with the Vidian nerve through the Vidian canal to supply the uppermost part of the pharynx, the Eustachian tube, and the tympanum.

The *pterygo-palatine artery*, which is very small, passes backward with the pharyngeal nerve through the pterygo-palatine canal to supply the upper pharynx, the sphenoid cells, and the Eustachian tube.

The *naso-palatine or spheno-palatine*, the terminal artery, runs inward through the naso-palatine or spheno-palatine foramen into the superior meatus of the nose. It crosses the roof of this meatus between the mucous membrane and the bone to

PLATE CXLIV.


Temporal m.
Superficial temporal a.
Auriculo-temporal n.
Anterior deep temporal a.
Anterior temporal n.
Orbital n.
Superior maxillary n.
Meckel's ganglion
Infraorbital a.
Posterior superior dental n.
Posterior temporal n.
Long buccal n.
Chorda tympani n.
Lingual n.
Internal lateral ligament of lower jaw
Buccinator m.
Inferior dental n.
Inferior dental a.
Inferior maxillary n.
Middle meningeal a.
Tympanic a.
Small meningeal a.
Internal maxillary a.
External carotid a.
Inferior dental a.
Internal pterygoid m.
Mylo-hyoid a.
Mylo-hyoid n.

reach the septum of the nose, runs downward and forward in a groove on the vomer, to anastomose with the posterior palatine artery. Two or three external branches are distributed to the mucous lining of the lateral nasal walls, the antrum of Highmore and the ethmoid and sphenoid cells.

The **veins** of the pterygo-maxillary region accompany the branches of the internal maxillary artery, and converge toward the external pterygoid muscle, around which they form a dense plexus—the **pterygoid plexus.** This is drained from its posterior part by a short venous trunk, called the *internal maxillary vein*, which accompanies the first (maxillary) portion of the internal maxillary artery into the substance of the parotid gland. The internal maxillary vein joins the temporal vein to form the temporo-maxillary vein. The pterygoid plexus sends a branch (*anterior maxillary or deep facial vein*) from its anterior part over the buccinator muscle to the facial vein. It also communicates with the cavernous sinus by means of a small emissary vein which passes through the foramen Vesalii in the sphenoid bone.

The **lymphatics** of this region accompany the blood-vessels, and are derived from the regions which those vessels supply and drain. They empty into the deep cervical glands.

The **nerves** of the pterygo-maxillary region are the inferior maxillary division of the fifth nerve and some of its branches and the chorda tympani nerve.

The *inferior maxillary nerve* leaves the cranial cavity through the foramen ovale. It emerges from the skull as a thick trunk, which lies external to the Eustachian tube and beneath the external pterygoid muscle. It differs from the other two divisions of the fifth nerve—the ophthalmic and the superior maxillary—in being composed of both motor and sensory fibers. After leaving the skull it divides into two portions, an anterior and a posterior. From the *anterior portion*, chiefly motor, are derived the anterior and posterior deep temporal nerves, the masseteric nerve, branches to the pterygoid muscles, and the long buccal nerve. The *posterior division*, chiefly sensory, divides into three large branches: the auriculo-temporal, the

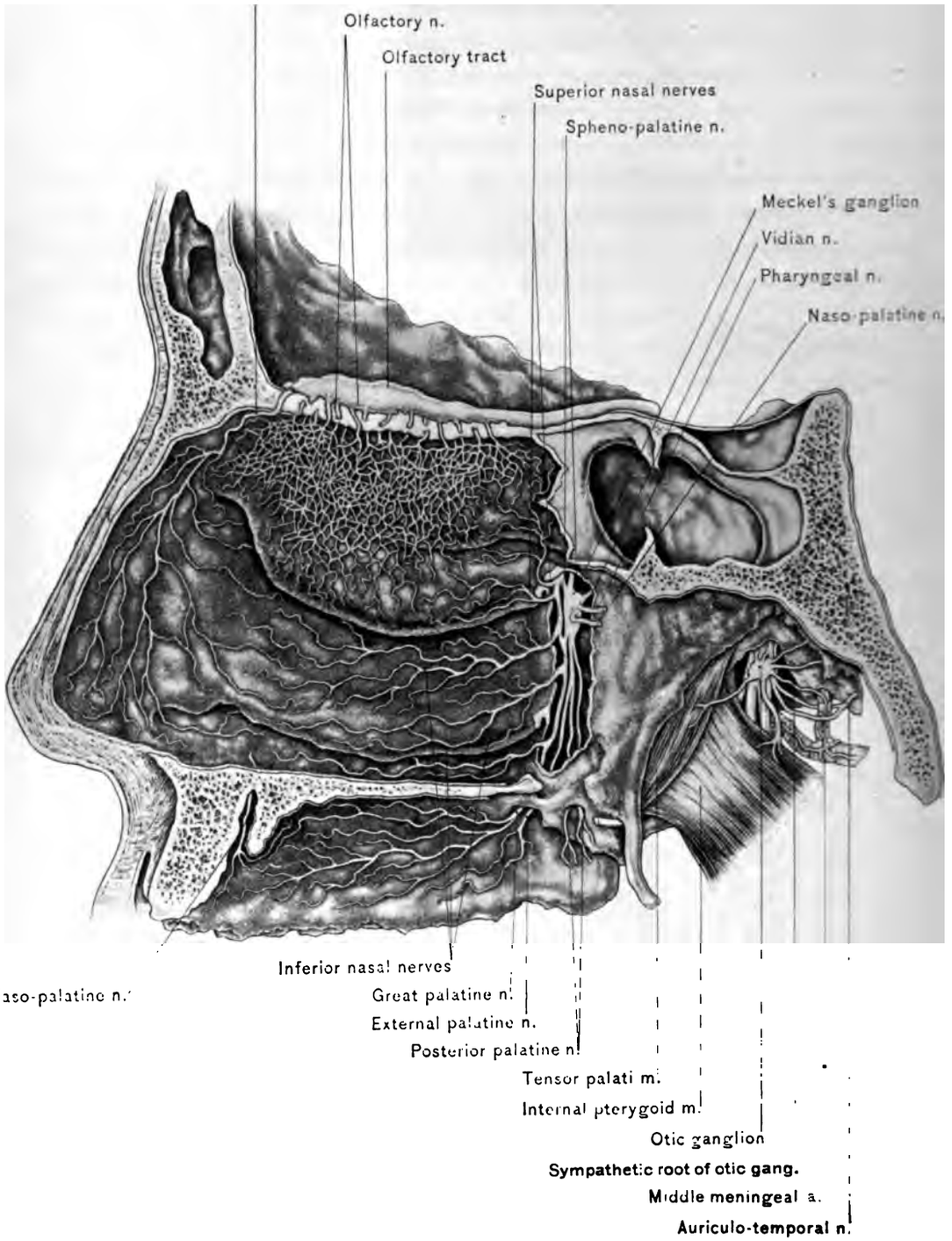
lary nerve before it divides; it gives off a branch to the otic ganglion, and enters the deep surface of the muscle. The **branch to the external pterygoid muscle** is, usually, a twig of the long buccal nerve, and divides into two branches, which enter the deep surface of the muscle.

The **long buccal,** a sensory nerve, is derived from the anterior portion of the inferior maxillary division of the fifth nerve. It runs between the two heads of the external pterygoid muscle, and passes downward and forward beneath the temporal muscle and the anterior edge of the masseter to the buccinator muscle, upon the outer side of which it communicates with the facial nerve and forms a plexus from which filaments pass to the adjacent mucous membrane and skin of the cheek. It contains all of the sensory fibers of the anterior division of the inferior maxillary nerve, and a few fibers from the motor root of the fifth nerve. The motor fibers run to the external pterygoid and temporal muscles.

The **auriculo-temporal nerve** arises by two roots, between which passes the middle meningeal artery. It runs backward and outward beneath the external pterygoid muscle, between the internal lateral ligament and the temporo-maxillary joint, curves outward around the neck of the condyle of the lower jaw, and pierces the upper part of the parotid gland. It next ascends over the root of the zygoma, in front of the external auditory meatus and beneath the temporal artery. In its course it receives communicating twigs from the otic ganglion, and supplies branches to the external auditory meatus, the parotid gland, and the temporo-maxillary articulation. From the parotid gland it sends a communicating branch to the temporo-facial division of the facial nerve. It divides near the level of the tragus into the anterior auricular and superficial temporal branches. The *anterior auricular* supplies the upper part of the pinna. The *superficial temporal* lies on the outer side of the superficial temporal vessels, divides, and accompanies the anterior and posterior temporal arteries.

The **lingual** (gustatory) **nerve** emerges from beneath the lower edge of the external pterygoid muscle, whence it descends internal to the inferior dental nerve between the lower jaw and the internal pterygoid muscle; thence it runs beneath

PLATE CXLV.


Nasal n.
Olfactory n.
Olfactory tract
Superior nasal nerves
Spheno-palatine n.
Meckel's ganglion
Vidian n.
Pharyngeal n.
Naso-palatine n.
Inferior nasal nerves
Naso-palatine n.
Great palatine n.
External palatine n.
Posterior palatine n.
Tensor palati m.
Internal pterygoid m.
Otic ganglion
Sympathetic root of otic gang.
Middle meningeal a.
Auriculo-temporal n.

ganglion, mucous membrane of the mouth, gums, sublingual gland, and lingual branches to the papillæ on the sides and tip of the tongue. As the lingual nerve supplies the tongue with common sensation, the pain due to neuralgia or cancer of the tongue may be relieved by division of this nerve. The incision should be made through the mucous membrane of the floor of the mouth opposite the second molar tooth of the lower jaw and close to the gum, where the nerve lies immediately beneath the mucous membrane.

The **inferior dental nerve,** the largest branch of the inferior maxillary, emerges from beneath the lower head of the external pterygoid muscle and descends between the internal lateral ligament and the ramus of the lower jaw to enter the inferior dental canal. At its origin it lies internal to the inferior dental artery, which it crosses at the inferior dental foramen; the artery is, therefore, nearer the teeth than the nerve. It is a sensory motor nerve, lying external to the lingual nerve and more superficial, the motor filaments being given off as the mylo-hyoid nerve just previous to its entrance into the inferior dental canal.

The **mylo-hyoid nerve** is accompanied by the mylo-hyoid artery, pierces the internal lateral ligament of the lower jaw, and descends to the mylo-hyoid groove upon the inner surface of the lower jaw. It then runs over the superficial surface of the mylo-hyoid muscle, supplying it and the anterior belly of the digastric muscle. In the inferior dental canal the inferior dental nerve supplies branches to the molar and bicuspid teeth and to the gums, and divides into an incisive and a mental branch opposite the mental foramen.

The **incisive branch** passes forward and inward in the inferior dental canal to supply the canine and incisor teeth and the adjacent region of the gum.

The **mental branch** emerges upon the face at the mental foramen, and after communicating with the supra-maxillary branch of the facial nerve divides into several branches. These supply the mucous membrane of the lower lip and the fascia and skin of the lip and chin.

The **chorda tympani nerve** arises from the facial in the aqueductus Fallopii, almost one-fourth of an inch above the stylo-mastoid foramen. It runs in the iter chordæ posterius to the middle ear, where it passes between the handle of the malleus and the fibrous layer of the membrana tympani externally, and the

meningeal artery, and may be found by tracing any of the larger branches of the nerve until the root of the parent stem, near the foramen ovale, is reached. Its sympathetic root is derived from the plexus on the middle meningeal artery; its sensory root from the inferior maxillary through the internal pterygoid nerve; its motor root from the small superficial petrosal nerve, which communicates with the tympanic branch of the glosso-pharyngeal nerve. It communicates with the auriculo-temporal and chorda tympani nerves. Motor fibers of the inferior maxillary nerve pass through it to the tensor palati and tensor tympani muscles.

Dissection.—To study the first portion of the internal maxillary artery and its branches, the trunk of the inferior maxillary nerve, the origins of its branches, and the otic ganglion, it is necessary to remove the external pterygoid muscle, the condyle of the jaw, and the remainder of the ramus as far as the transverse incision in the ramus.

Fracture of the base of the skull may cause serious hemorrhage into the pterygo-maxillary region, because of rupture of the meningeal vessels. Lacerations of the deep temporal vessels due to cranial fracture would result in the effusion of blood into this space, its escape above the zygoma being rendered impossible because of the attachments of the temporal fascia. Under these conditions pain on pressure made below the zygoma and behind the malar bone would be a rational symptom. Such effusion might give rise to secondary irritation of the nerves in this space. Thus, irritation of the chorda tympani nerve would cause salivation; of the lingual, disturbances of sensation and taste at the end of the tongue; of the inferior dental, toothache; of the motor branches, tonic or clonic spasms of the muscles of mastication; of the mylo-hyoid and anterior belly of the digastric muscles, more or less complete fixation of the jaw.

Tumors and abscess would have similar effects, but would vary in degree in accordance with the exact location and rapidity of growth. Owing to the presence of important structures in this space, it is well to practise Hilton's method of opening a deep abscess in this region; this is done as follows: Through an incision in the skin push a grooved director into the abscess; then insert a pair of forceps along the director, and withdraw them with the blades sufficiently separated to make an opening large enough to insure good drainage. It is impossible to do serious damage by this procedure.

Dissection.—The pterygo-maxillary region should now be thoroughly cleaned, in order to study the spheno-maxillary fissure, the pterygo-maxillary fissure, and the spheno-maxillary fossa.

It will be remembered that the zygomatic fossa was mentioned in connection with the contents of the pterygo-maxillary region; its contents have been dissected.

They consist of the lower part of the temporal muscle, the internal and external pterygoid muscles, the internal maxillary artery, the inferior maxillary nerve, branches of the artery and nerve, and the chorda tympani nerve.

The **zygomatic fossa** practically corresponds to the upper portion of the pterygo-maxillary region. It is bounded above by the under surface of the great wing of the sphenoid and adjacent portion of the temporal bone; in front, by the zygomatic surface of the superior maxilla; behind, by the posterior border of the pterygoid process of the sphenoid bone and the eminentia articularis; internally, by the external pterygoid plate; and externally, by the pterygoid ridge, the zygomatic arch, and the ramus of the inferior maxilla. At the upper and inner part of the zygomatic fossa two fissures will be observed, one horizontal, the other vertical. The horizontal fissure is the spheno-maxillary, which opens into the outer and back part of the orbit. It transmits the infra-orbital artery and vein, branches from Meckel's ganglion, and the superior maxillary nerve and its orbital branch. Its bony walls are formed, above, by the lower border of the orbital surface of the great wing of the sphenoid; below, by the orbital surface of the superior maxilla and a portion of the palate bone; externally, by a small part of the malar bone. It joins the pterygo-maxillary fissure at a right angle. The vertical fissure is the pterygo-maxillary, which is formed by the angle between the superior maxillary bone and the pterygoid process of the sphenoid bone. It transmits the internal maxillary artery.

The **spheno-maxillary fossa** lies below the great wing of the sphenoid, external to the vertical portion of the palate bone, and between the orbital process of the palate bone and the zygomatic surface of the superior maxilla, in front, and the pterygoid process, behind. It contains the terminal portion of the internal maxillary artery, the branches of this portion, the superior maxillary nerve, and Meckel's ganglion. Three foramina are found in the posterior wall: the *foramen rotundum*, which transmits the superior maxillary division of the fifth nerve; below

become the infra-orbital nerve. Its branches are: In the cranial cavity, *recurrent twigs* to the dura mater, which communicate with branches of the inferior maxillary nerve; in the spheno-maxillary fossa, *orbital* or *temporo-malar*, *spheno-palatine*, and *posterior superior dental branches;* in the infra-orbital canal, *middle superior dental* and *anterior superior dental nerves;* and upon the face, the terminal divisions of the infra-orbital nerve, the *palpebral*, *nasal*, and *labial branches*. In the spheno-maxillary fossa Meckel's ganglion is associated with it.

Dissection.—Remove the outer wall of the orbit and that portion of the greater wing of the sphenoid bone external to the foramen rotundum by sawing downward from the incised edge of the skull made in removing the brain. The saw should pass through the outer part of the sphenoid fissure and external to the foramen rotundum.

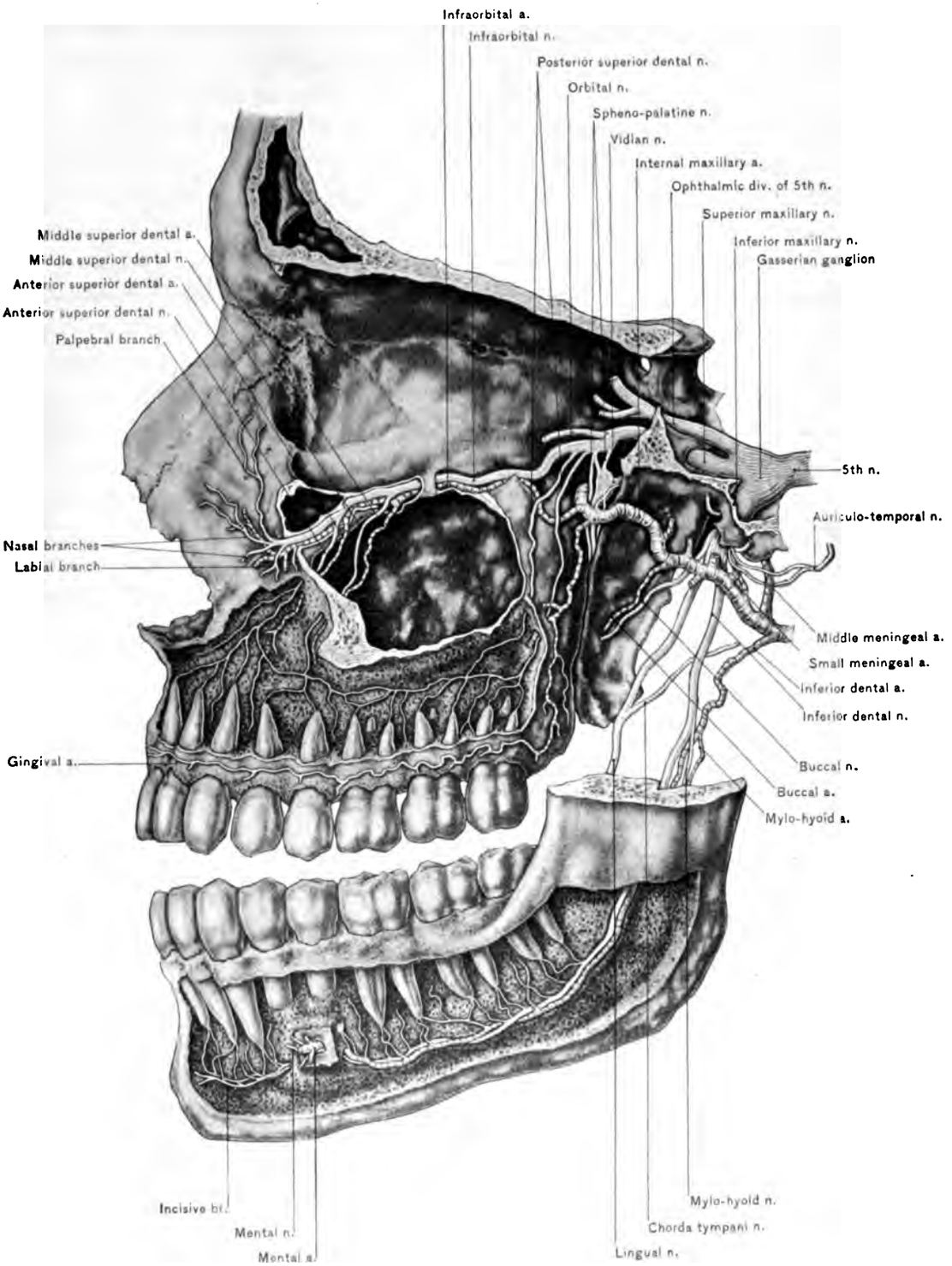
The **orbital or temporo-malar nerve** enters the orbit through the spheno-maxillary fissure. At the posterior part of the orbit it divides into a temporal and a malar branch. The *temporal branch* runs forward in the periosteum, lying in a groove in the bone, and passes through a foramen in the malar bone (spheno-malar foramen) to enter the temporal fossa. It runs upward beneath the temporal muscle, piercing it and both lamellæ of the temporal fascia to supply the skin of the temporal region; it pierces the superficial layer of the temporal fascia about an inch above the zygoma. In the orbit it communicates with the lacrymal nerve; and in the temporal region with the temporal branch of the facial nerve. The *malar branch* (ramus subcutaneus malæ) runs forward along the external and inferior portion of the orbit, passes through the malar foramen, pierces the orbicularis palpebrarum, and supplies the skin of the cheek. It communicates with the malar branch of the facial nerve and with the palpebral branches of the infra-orbital nerve.

The **spheno-palatine branches** are two twigs which descend to Meckel's ganglion from its sensory root.

The **posterior superior dental nerves** are, usually, two in number, and arise from the superior maxillary nerve as it enters the infra-orbital canal. They pass downward and enter the foramina in the zygomatic surface of the superior maxilla; they next run forward in canals in the outer wall of the antrum of Highmore and above the roots of the molar teeth to join the middle superior dental nerve. They supply branches to the pulp of the molar teeth, to the gums, and to the mucous membrane of the antrum of Highmore.

The **middle superior dental nerve** is given off at the posterior part of the infra-orbital canal, or it may be a branch of the anterior superior dental nerve. It supplies the bicuspid teeth and communicates with the anterior superior and

PLATE CXLVI.


Infraorbital a.
Infraorbital n.
Posterior superior dental n.
Orbital n.
Spheno-palatine n.
Vidian n.
Internal maxillary a.
Ophthalmic div. of 5th n.
Superior maxillary n.
Inferior maxillary n.
Gasserian ganglion
Middle superior dental a.
Middle superior dental n.
Anterior superior dental a.
Anterior superior dental n.
Palpebral branch
5th n.
Auriculo-temporal n.
Nasal branches
Labial branch
Middle meningeal a.
Small meningeal a.
Inferior dental a.
Inferior dental n.
Gingival a.
Buccal n.
Buccal a.
Mylo-hyoid a.
Incisive br.
Mental n.
Mental a.
Mylo-hyoid n.
Chorda tympani n.
Lingual n.

The **anterior superior dental nerve** is larger than the other two superior dental nerves, and arises posterior to the infra-orbital foramen; it runs downward in the anterior wall of the antrum of Highmore, and supplies the incisor and canine teeth, and also a branch to the nasal fossa. The anterior and middle superior dental nerves may be seen by raising the superior maxillary nerve from the floor of the infra-orbital canal.

The **infra-orbital nerve** emerges upon the face at the infra-orbital foramen, which lies beneath the levator labii superioris muscle. It divides here into palpebral, nasal, and labial branches, which, with the infra-orbital branch of the facial nerve, form the *infra-orbital plexus.*

The *palpebral branches* pierce the origin of the levator labii superioris muscle and supply the integument and conjunctiva of the lower eyelid.

The *nasal branches* pass inward under the levator labii superioris alæque nasi muscle to supply the skin of the nose.

The *labial branches* are the largest and most numerous. They run downward beneath the levator labii superioris muscle to supply the skin, mucous membrane, and other tissues of the upper lip.

Meckel's or the spheno-palatine ganglion is situated in the spheno-maxillary fossa below the superior maxillary nerve. It is triangular in shape, of a reddish-gray color, and measures about one-fifth of an inch in its longest diameter. Its sensory root is derived from the superior maxillary through the spheno-palatine nerve, most of the fibers of which do not enter the ganglion but pass anterior to it. Its motor root is derived from the facial through the great superficial petrosal nerve, which assists the great deep petrosal in forming the Vidian nerve. Its sympathetic root, the great deep petrosal nerve, just mentioned, is derived from the carotid plexus. The motor and sympathetic roots enter the spheno-maxillary fossa as the Vidian nerve. Its branches are classified as ascending, descending, internal, and posterior.

The **ascending or orbital branches** pass through the spheno-maxillary fissure, and pierce the inner wall of the orbit to supply the mucous membrane of the sphenoid sinus and posterior ethmoid cells.

The **descending or palatine branches** are derived mainly from the spheno-palatine branches of the superior maxillary nerve. They are divided into anterior,

rior palatine canal it gives off two branches (inferior nasal nerves), which pierce the vertical plate of the palate bone to supply the mucous membrane of the back part of the middle and inferior meatuses and the inferior turbinated bone.

The *external or middle palatine nerve*, when present, is small; it descends in the external palatine canal to supply the tonsil and adjacent mucous membrane.

The *posterior or small palatine nerve* descends in the accessory palatine canal to supply the tonsil, adjacent mucous membrane, levator palati, and azygos uvulæ muscles. With the external palatine nerve it joins a branch from the glosso-pharyngeal nerve to form the *circulus tonsillaris*, a plexus around the tonsil.

The **internal or nasal branches** are derived partly from the spheno-palatine ganglion and partly from the spheno-palatine nerve. They are divided into septal and superior nasal branches.

The *septal branches* pass through the spheno-palatine foramen with the naso-palatine artery, and cross the roof of the nasal fossa beneath the mucous membrane and below the opening of the sphenoid sinus to reach the septum, where the smaller branches terminate.

The *naso-palatine nerve* (nerve of Cotunnius), the largest of these branches, runs downward and forward on the septum of the nose, between the periosteum and the mucous membrane, to the anterior palatine canal, where it passes through one of the foramina of Scarpa (subdivisions of the anterior palatine foramen) to supply the mucous membrane of the anterior portion of the hard palate and to join the terminal portion of the anterior palatine nerve.

The *superior nasal nerves* are several twigs which pass through the spheno-palatine foramen to supply the mucous membrane of the posterior part of the middle and superior turbinated bones, and of the posterior ethmoid cells and antrum of Highmore.

The **posterior branch** is the pharyngeal nerve.

The **pharyngeal or pterygo-palatine nerve** runs backward through the pterygo-palatine canal in company with the pterygo-palatine artery; it supplies the upper portion of the pharynx and the Eustachian tube.

The **Vidian nerve** has been considered a posterior branch of the spheno-palatine ganglion, but it is really the nerve which is formed by the junction of its motor and sympathetic roots. It will be seen emerging from the Vidian canal at the root of the pterygoid process.

The **superior maxillary nerve** and its many communications are especially

area of distribution of the nerve, and abscess or tumors of the antrum of Highmore, of the pterygo-maxillary region, or of the spheno-maxillary fossa. The **infra-orbital foramen** is on a line drawn from the supra-orbital notch to a point between the bicuspid teeth of the upper jaw. It corresponds to a point about one-half of an inch below the junction of the inner and the middle one-third of the infra-orbital margin. The infra-orbital nerve is best exposed through a semilunar incision with its convexity directed downward, and carried a short distance below the foramen. A flap, including skin, cellular tissue, and the orbicularis palpebrarum muscle, is raised. The levator labii superioris muscle, which covers the foramen, is now apparent, and must be displaced laterally or divided, when both the infra-orbital plexus and nerve will readily be found, surrounded by a small quantity of fatty tissue.

In some cases of obstinate neuralgia of the peripheral branches of the trifacial nerve it becomes necessary to remove a portion of the affected nerve in order to give the patient relief. The infra-orbital nerve may be divided at its exit from the infra-orbital foramen by either a subcutaneous or a conjunctival section; in the latter method the tenotome is introduced through the conjunctiva and carried over the infra-orbital margin; it is best to expose the infra-orbital nerve by turning up a flap from the face, when a portion of the nerve can be removed. The nerve being exposed and freed at its point of exit, a slightly curved or hooked knife can be entered close to the external canthus just below the outer palpebral ligament, and passed backward along the floor of the orbit toward the apex, and along the anterior border of the spheno-maxillary fissure, which is crossed by the nerve at about an inch behind the orbital margin. The knife is then carefully withdrawn, and the nerve divided as it enters the infra-orbital canal. Traction is then made upon the peripheral end of the nerve to remove it from the infra-orbital canal. Should the knife be carried too far and the spheno-maxillary fossa be entered, serious hemorrhage would result.

The objections to this last method are, first, the hemorrhage which results from the division of the infra-orbital vessels inaccessible for ligature; second, the uncertainty of accomplishing the division of the nerve; and third, in many of these cases the posterior, as well as the anterior, dental branches are involved; if this be the case, removal of the superior maxillary nerve behind Meckel's ganglion will be required in order to insure positive relief.

The best method for removing the superior maxillary nerve through the face from behind Meckel's ganglion is the following: Expose and free the infra-orbital nerve at its exit from the infra-orbital foramen; then, with a three-quarter-inch trephine, remove a button of bone from the anterior wall of the antrum of Highmore; this button should include the outer wall of the infra-orbital foramen, and

the infra-orbital nerve from its canal, the author has, by simply cleaning out the track of the original wound, seen relief follow.

In trifacial neuralgia one, two, or all three branches of the trifacial nerve may be involved. The ophthalmic division supplies the skin above the palpebral fissure; the superior maxillary division, the skin between the palpebral and oral fissures, including the temple; the inferior maxillary division supplies the skin below the oral fissure as far as the hyoid bone. The superior and the inferior maxillary nerves also supply the teeth through their branches, while the latter supplies the anterior two-thirds of the tongue through its lingual branch; the motor root of the third division also supplies the muscles of mastication, except the buccinator—*i. e.*, the temporal, masseter, and external and internal pterygoid muscles. Thus, *complete paralysis* of the trifacial nerve abolishes sensation upon one side of the face and on top of the head, from the highest point of the vertex above to the hyoid bone below; laterally, to and including the front of the ear and external auditory canal and temple; mesially, the anterior nares and the sensibility as to touch and taste of the anterior two-thirds of the tongue, besides completely paralyzing the muscles of mastication on the affected side, with the exception of the buccinator. Because of the insensibility of the conjunctiva the lids do not properly protect this membrane, and it becomes congested and inflamed, a condition which often occurs spontaneously through implication of the trophic fibers of the trifacial nerve. At the same time anterior rhinitis may result from similar causes, or may be excited by the discharge of the conjunctival secretion into the inferior meatus of the nose.

Trifacial neuralgia may be accompanied by active implication of the trophic filaments, so that there is not only conjunctivitis and rhinitis, but vesicles may form upon the lips and anterior nares. This should be borne in mind, as these trophic nerve disturbances, when overlooked, may be the source of much perplexity to the physician.

Paralysis of the orbicularis palpebrarum muscle also leads to conjunctivitis, from inability to close the eyelids; this must not be confounded with the inflammation of perverted function of the trophic nerves.

The **trophic filaments** are derived from the sympathetic nerve; this is a general rule worth remembering.

The entire width of the occiput, as high up as the vertex, and the back of the pinna are supplied by the occipitalis major nerve. As Hilton pointed out, the pinna may, therefore, often be used to differentiate between spinal and cerebral central nerve disease causing neuralgia; if spinal, the back of the pinna is affected

nerve because of the abundance of its filaments and their numerous inosculations. The physician must, therefore, be careful not to be misled by the location of pain, for an earache may be due to a diseased tooth, as was the case in a patient treated by Hilton: The patient had consulted several leading aurists for a persistent earache without obtaining relief except from the use of anodynes; the ingenious Hilton sagaciously concluded it to be useless to treat where so many others had failed, and looked elsewhere than at the ear for the cause of the trouble. This he found in a jagged molar tooth which was continually irritating a small nerve filament at the bottom of an ulcer upon the side of the tongue adjoining the tooth. He advised the removal of the tooth, which resulted in healing of the ulcer and in cure of the earache. In a similar manner affections of any filament of the trifacial nerve may produce pain in any part supplied by other branches of the nerve.

The **Lymphatic Glands of the Head** are divided into a superficial and a deep set. The **superficial set** is composed of the occipital, posterior auricular, parotid, buccal, and submaxillary lymphatic glands.

The **occipital or suboccipital lymphatic glands** are situated in the superficial fascia along the superior curved line of the occipital bone over the attachments of the trapezius muscle and the occipital belly of the occipito-frontalis muscle. These glands receive the lymphatic vessels from the posterior portion of the scalp or that area supplied by the occipital artery, and may be involved in erysipelas or other septic conditions of the posterior portion of the scalp. The efferent vessels from these glands empty into the superficial lymphatic glands of the neck.

The **posterior auricular or mastoid lymphatic glands** are situated behind the pinna, over the mastoid process and the insertion of the sterno-mastoid muscle. They receive the lymphatic vessels from the posterior auricular region and the portion of the scalp above it. Their efferent vessels empty into the superficial lymphatic glands of the neck.

The **parotid lymphatic glands** lie upon the parotid salivary gland in front of the pinna, below the zygoma, and a few are found in the substance of the parotid salivary gland. They receive the lymphatic vessels from the temporal region, the portion of the scalp above it, and the outer portion of the eyelids and of the cheek. Their efferent vessels empty into the superficial lymphatic glands of the neck and

situated below the border of the lower jaw, most of them lying in the submaxillary triangle in relation with the submaxillary salivary gland; two or three of them (supra-hyoid lymphatics) lie above the body of the hyoid bone, between the anterior bellies of the two digastric muscles. The submaxillary lymphatic glands receive the lymphatic vessels from the front of the scalp, inner part of the eyelids, anterior portion of the face, floor of the mouth, anterior portion of the tongue, sublingual and submaxillary salivary glands, and some of the efferent vessels from the parotid lymphatic glands. Their efferent vessels empty into the superficial and deep cervical lymphatic glands.

The **deep lymphatic glands** of the head are the internal maxillary, lingual, and post-pharyngeal lymphatic glands.

The **internal maxillary lymphatic glands** are situated in the pterygo-maxillary region; some are in relation with the internal maxillary artery, others lie upon the posterior portion of the buccinator muscle, and still other deep glands lie upon the side of the pharynx. They receive the lymphatic vessels from the orbital, nasal, temporal, and zygomatic fossæ, the roof of the mouth, and the soft palate, and some of the efferent vessels from the buccal lymphatic glands. Their efferent vessels empty into the deep cervical lymphatic glands and partly into the deep parotid lymphatic glands.

The **lingual lymphatic glands** lie upon the hyo-glossus and genio-hyo-glossus muscles. They receive the lymphatic vessels from the upper surface and posterior part of the tongue. Their efferent vessels unite with the upper glands of the deep cervical chain.

The **post-pharyngeal lymphatic gland** is situated below the base of the skull, between the posterior wall of the pharynx and the rectus capitis anticus major muscle. It receives the lymphatic vessels from the upper part of the pharynx, part of the nasal fossa, and the upper part of the prevertebral muscles.

The **lymphatic vessels of the scalp,** which drain that portion behind a ver-

the eyelids and outer part of the cheek terminate in the parotid lymphatic glands. The *deep lymphatics of the face—i. e.*, those of the orbit, part of the nasal fossa, the hard and soft palates, deeper portion of the cheek, temporal fossa, and pterygo-maxillary region—enter the internal maxillary lymphatic glands.

From the course of the lymphatic vessels it follows that in septic conditions, such as infected wounds, erysipelas, and abscess of the posterior portions of the scalp, the occipital and posterior auricular glands may become affected, and that in the same condition of the lateral part of the scalp the parotid lymphatic glands may become enlarged or inflamed, and septic matter from the frontal region of the scalp may eventually reach the submaxillary lymphatic glands. The course of the lymphatic vessels usually corresponds to that of the veins.

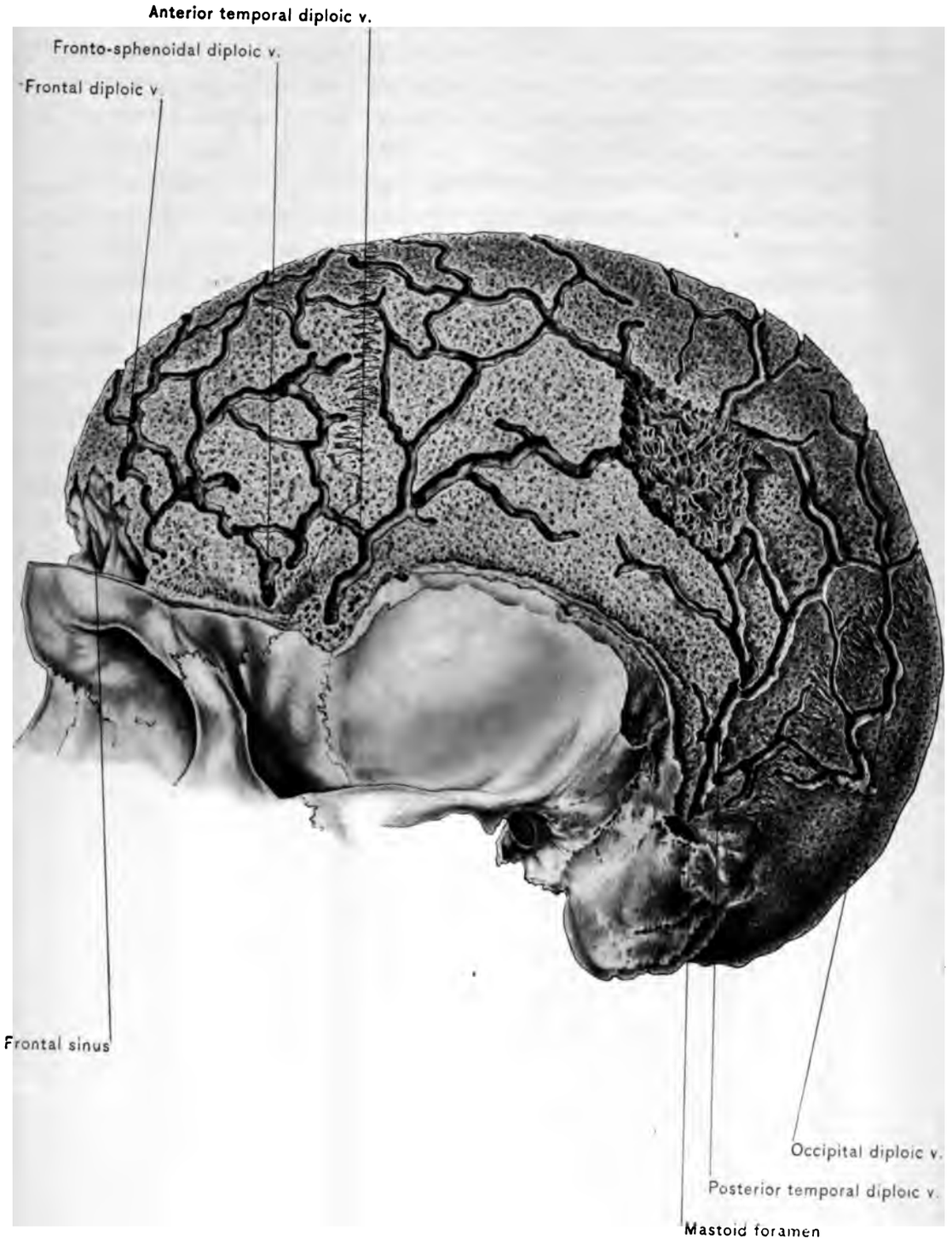
Metastasis from carcinomatous growths generally follows the lymphatic vessels. In septic conditions or carcinomata of the anterior portion of the face, of the lips, of the tongue, and of the sublingual and submaxillary salivary glands the submaxillary lymphatic glands become enlarged. Similar affections of the outer part of the eyelids and face involve the parotid lymphatic glands; and in corresponding conditions of the orbital, nasal, temporal, and zygomatic fossæ, of the deeper tissues of the cheek and of the roof of the mouth, the internal maxillary lymphatic glands may be affected.

Before dissecting the neck, the student should remove the brain and place it in a solution to prepare it for dissection; he should study the diploic veins, the dura mater and its processes, trace the meningeal vessels and the sinuses, and follow the cranial nerves to their respective foramina of exit from the cranial cavity. These structures and their dissection are described under the Membranes and Vessels of the Brain.

THE MEMBRANES AND VESSELS OF THE BRAIN.

Dissection.—Before removing the calvaria, or skull cap, entire, its outer compact table should be removed on one side, so as to expose the diploë or middle table, with its bony channels for the accommodation of the diploic veins. This is most readily done by sawing through the outer table in the horizontal line described in the removal of the calvaria as a whole, and in the sagittal line of the skull, when, with a chisel, it can be lifted off piecemeal. To remove the por-

PLATE CXLV


Anterior temporal diploic v.
Fronto-sphenoidal diploic v.
Frontal diploic v.
Frontal sinus
Occipital diploic v.
Posterior temporal diploic v.
Mastoid foramen

however, in different subjects (Merkel). These veins are distinct before the cranial bones unite with one another, after which there is a free anastomosis between them. In young subjects they are small, but they increase in size as age advances (Quain). They have no valves, and their walls are extremely thin.

The **frontal veins** are situated in the anterior part of the frontal bone; they pass most frequently through the supra-orbital foramen and empty into the supra-orbital vein; they may, however, empty into the fronto-sphenoid vein. Varicosity of this vein, even to the extent of causing absorption of the outer table of the bone, may occur.

The **fronto-sphenoid veins** lie in the lateral part of the frontal and in the sphenoid bone; they empty into the sinus alæ parvæ.

The **fronto-parietal or anterior temporal veins** are situated in the posterior part of the frontal and in the anterior part of the parietal bone; externally they empty into the deep temporal veins, and internally into the superior petrosal sinus or a meningeal vein.

The **external parietal or posterior temporal vein** is situated in the parietal bone; it passes through a foramen in the posterior inferior angle of this bone, or through the mastoid foramen to empty into the lateral sinus.

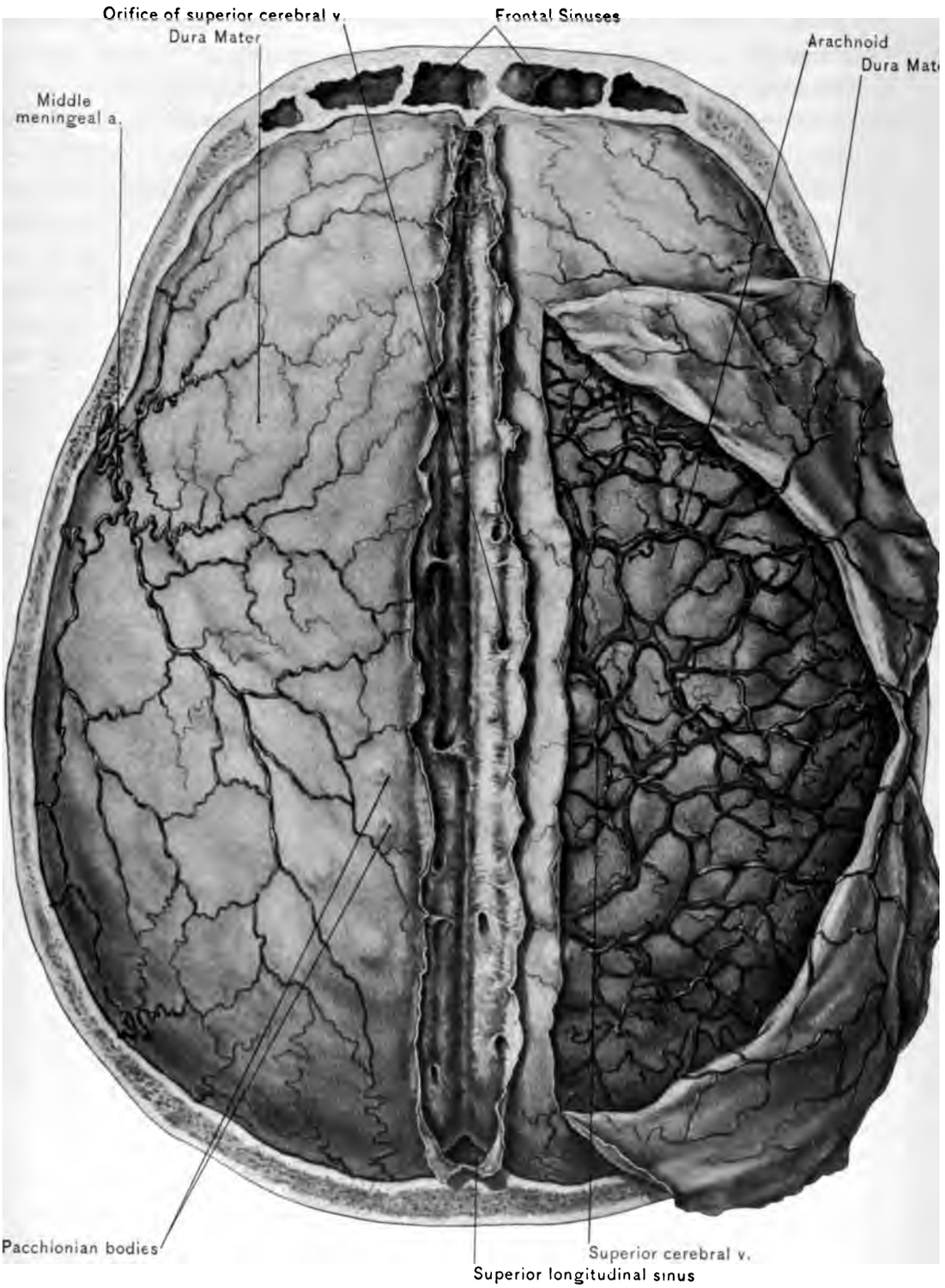
The **occipital or parieto-occipital vein,** the largest of the diploic veins, is confined to the occipital bone; it empties externally into the occipital vein, or internally into the lateral sinus.

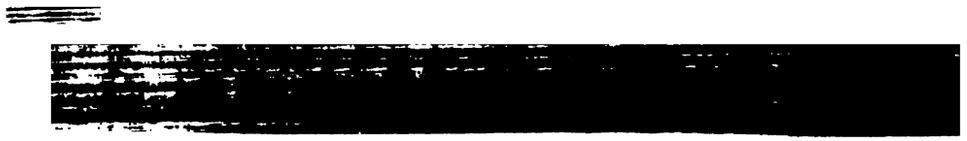
In **compound fractures of the skull** the diploic veins offer an opening favorable to the introduction of septic matter into the circulation, thereby permitting thrombosis of the sinuses, septic meningitis, general sepsis (pyemia), or, possibly, abscess of other organs, especially the liver. The diploic veins communicate with those of the scalp by means of very small vessels; through these the septic matter may be conveyed to the diploic veins and thence to the sinuses. It is doubtless through one or more of these emissary veins, in the majority of cases, that septic material—the result of inflammation of the scalp—enters the venous system.

Dissection.—Remove the calvaria (skull cap) by sawing through the outer and middle tables along a line carried horizontally around the skull, connecting a point one-half of an inch above the supra-orbital margin with a point the same distance above the external occipital protuberance; then, with a chisel and mallet, cut through the inner table, prying the calvaria from the underlying dura mater. In breaking through the inner table the mallet and chisel are preferred to the saw, there being less danger of cutting the dura mater; even when closely adhe-

Pacchionian bodies.—The outer surface of the dura mater being exposed by removal of the skull cap, it appears rough, especially along the lines of the sutures and in the neighborhood of the foramina, where it is most closely attached to the bone. The anterior and posterior branches of the middle meningeal artery, with the corresponding veins, will be seen to ramify upon the dura mater over each hemisphere; in most instances granular masses, the Pacchionian bodies, which are villous processes of the arachnoid, will be observed upon the surface on each side of the middle line. The position of these bodies should be carefully noted, and they must not be regarded as pathologic when seen on the operating or postmortem table. In some cases they are quite large: the author has known one to be so large as to occasion sufficient pressure to give rise to focal (Jacksonian) epilepsy; the patient was trephined, and the enlarged Pacchionian body with the underlying cerebral cortex removed, in the belief that it was a neoplasm. The convulsions were arrested temporarily, but returned after a time; this, unfortunately, occurs in the majority of cases of Jacksonian epilepsy operated upon. These bodies are always impressed upon the calvaria, so that depressions, corresponding in size to the bulk of the bodies causing them, may be seen upon each side of the median line of the skull; at times they almost perforate the bone. As a rule, they hollow the bone out sufficiently to render it translucent. The existence of these bodies may, therefore, be ascertained by inspection of the interior of the calvaria, and it is even possible, by the aid of transmitted light, to determine their presence by examining from without. The Pacchionian bodies, as previously stated, are processes of the arachnoid, and serve as channels for the passage of the cerebro-spinal fluid into the venous sinuses of the dura mater; in this way they relieve intra-cranial pressure. They vary greatly in size in different persons, and in children are quite small.

The **dura mater,** the most external of the three membranes of the brain, forms the internal periosteum of the skull, and affords an excellent protection to the brain. Through the medium of this internal periosteum the bones of the skull receive the greater part of their nourishment; this explains why they seldom necrose in scalp wounds in which the pericranium or external periosteum is torn away. The dura mater is a dense, tough, inelastic, fibrous membrane. It is intimately adherent to the base of the skull, owing, partly, to the numerous foramina found there; therefore, extra-dural extravasations or collections of blood or pus between the dura and skull rarely, if ever, occur at the base of the skull; at the sides and roof of the cranial cavity, however, where the membrane is comparatively loosely attached (except along the sutures and around the foramina),


Orifice of superior cerebral v.
Dura Mater
Frontal Sinuses
Arachnoid
Dura Mat
Middle meningeal a.
Pacchionian bodies
Superior cerebral v.
Superior longitudinal sinus



an injury to the head, indicate depressed fracture; if they appear a short time thereafter, hemorrhage; some days after, pus. Tillaux has demonstrated that the dura mater is less firmly attached to the temporal fossa, the most frequent site of extra-dural hemorrhage, than to any other portion of the interior of the skull (Treves). It is most closely adherent to the bone in infancy and old age. It has been demonstrated by Sir Charles Bell that the dura mater may be separated from the vault and sides of the skull by striking the head of a cadaver a hard blow with a heavy mallet.

Extra-dural hemorrhage.—The most common cause of extra-dural hemorrhage is rupture of the branches of the **middle meningeal artery**; this is usually associated with fracture of the parietal bone at its anterior inferior angle, the site of the groove through which the anterior branch of the artery passes. The author has trephined for compression of the brain produced by an extra-dural clot not associated with fracture. The next most frequent source of extra-dural hemorrhage is the lateral sinus.

Attachments of the dura mater.—Besides being closely adherent to the base of the skull, the dura mater is continuous, through the optic foramen, with the periosteum of the orbit; through the foramen magnum, with the dura mater of the spinal canal; and through the fissures and the various foramina through which the vessels and nerves enter and leave the cranial cavity, clothed by prolongations of this membrane, with the pericranium. As the dura mater is directly continuous with these various structures, it can be readily understood how inflammation may extend by continuity into the cranial cavity and cause secondary meningitis.

Pulsations of the dura mater.—The dura mater, when exposed in the living subject, may present two distinct pulsations, communicated from the underlying brain: one synchronous with the pulsation of the arteries, the other with respiration, rising in expiration and sinking in inspiration.

Layers of the dura mater.—The dura mater consists of two layers: an outer,

backward, one-half of an inch on each side of the median line, thus avoiding the superior longitudinal sinus. From the center of these incisions carry a transverse incision upon each side as far as the divided margin of the bone. Reflect the flaps thus made, and with the fingers gently separate the hemispheres of the cerebrum. The falx cerebri, with the veins from the surface of the cerebrum which empty into the superior longitudinal sinus, may then be seen. The tentorium cerebelli can now be readily exposed by lifting up the posterior extremities of the hemispheres of the cerebrum (occipital lobes). Next lay open the superior longitudinal sinus and inspect its interior. The small openings of the veins from the top of the hemispheres (superior cerebral veins), the diploë, and the dura mater will be seen along its entire course; they generally enter from behind forward. Divide the anterior uncut portion of the dura mater, and sever the falx cerebri from its attachment to the crista galli, along with the veins which empty into the superior longitudinal sinus; together with the falx cerebri turn back the strip of dura mater in which is contained the superior longitudinal sinus.

Removal of the brain.—The brain should now be removed in the following manner:

Draw the subject well up so that the head will hang over the edge of the table. With the fingers of the left hand lift the frontal lobes of the cerebrum from the anterior cranial fossa and raise the olfactory bulbs from the cribriform plate of the ethmoid bone, thus severing the olfactory nerves. The optic nerves with the ophthalmic arteries beneath will now be seen, and both should be cut across (preferably with scissors), a short distance from the brain. By gently lifting and displacing the hemispheres backward, the internal carotid arteries and the infundibulum (a process of gray matter which connects the pituitary body with the tuber cinereum) will be seen. These should next be divided or the artery should be severed and the pituitary body removed from the pituitary fossa after incising the diaphragma sellæ. The third pair of cranial nerves, the oculo-motor, will be seen lying behind the anterior clinoid processes on their way to reach the cavernous sinuses. Divide these nerves and then, turning the head to the right, lift the temporo-sphenoid lobes from the middle cranial fossa, and the tentorium cerebelli will be brought into view. This should be cut through close to its attachment to the posterior clinoid process and to the petrous portion of the temporal bone. The pathetic, or fourth, and the trifacial, or fifth, pairs of cranial nerves should be severed on the left side; turn the head to the left, and divide the corresponding structures on the right side. Bring the face back to the middle line, draw the brain well backward, and divide the following structures from within outward in the order named: The abducens or sixth, the facial or seventh, the auditory or eighth, the glosso-pharyngeal or ninth, the pneumogastric or vagus or

PLATE CXLIX.

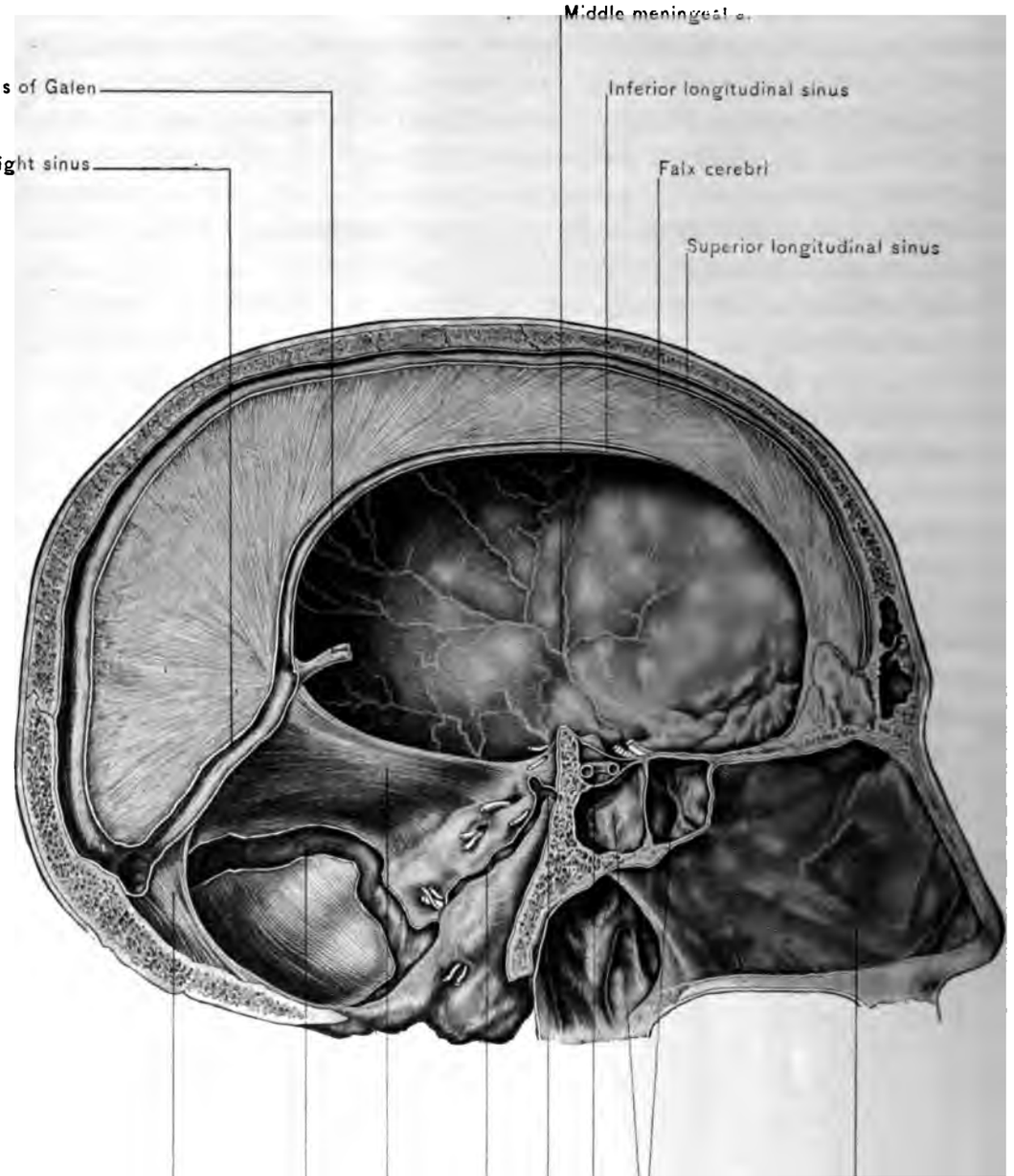
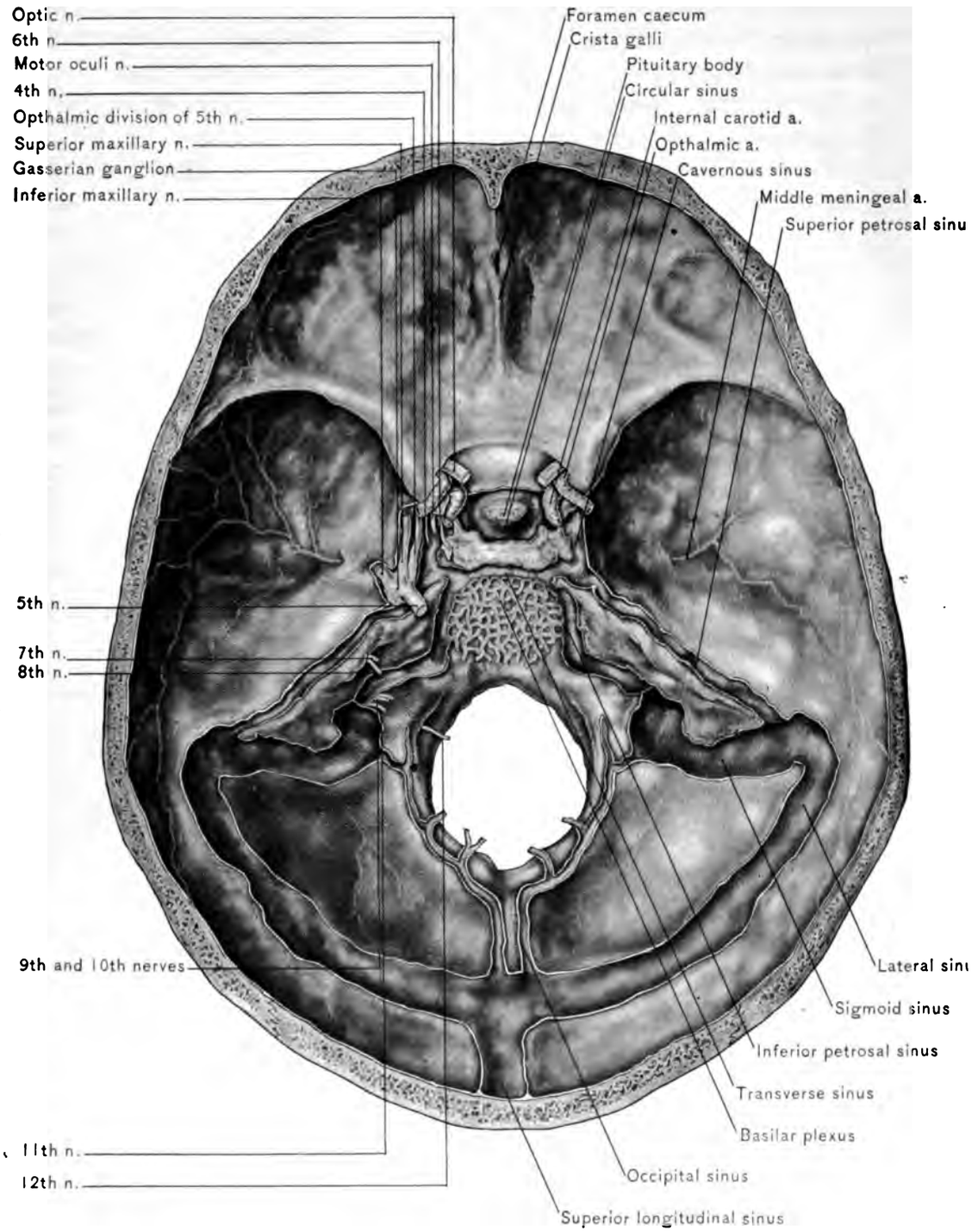

Middle meningeal a.
Veins of Galen
Inferior longitudinal sinus
Straight sinus
Falx cerebri
Superior longitudinal sinus
Nasal septum
Falx cerebelli
Lateral sinus
Tentorium cerebelli
Inferior petrosal sinus
Sphenoidal cells
Circular sinus
Transverse sinus

PLATE C


Optic n.
6th n.
Motor oculi n.
4th n.
Opthalmic division of 5th n.
Superior maxillary n.
Gasserian ganglion
Inferior maxillary n.
Foramen caecum
Crista galli
Pituitary body
Circular sinus
Internal carotid a.
Opthalmic a.
Cavernous sinus
Middle meningeal a.
Superior petrosal sinu
5th n.
7th n.
8th n.
9th and 10th nerves
11th n.
12th n.
Lateral sinu
Sigmoid sinus
Inferior petrosal sinus
Transverse sinus
Basilar plexus
Occipital sinus
Superior longitudinal sinus

tenth, the spinal accessory or eleventh, and the hypo-glossal or twelfth pair of cranial nerves. The next and final step consists of carrying a scalpel down into the spinal canal as far as possible and cutting through the spinal cord, the two vertebral arteries, and the spinal portions of the spinal accessory nerves. The fingers of the right hand should then be slipped beneath the cerebellum and pons, and the brain removed.

Preservation of the brain.—If the brain be not dissected at once, it should be placed in a solution of chlorid of zinc, in alcohol and formaldehyd, or Müller's fluid. If placed in the zinc solution, the pia mater should be removed later, for if allowed to remain in this solution for some time, it is more easily separated than in the fresh condition. If alcohol alone be used to preserve the brain, the pia mater must be removed before placing it therein; this is most readily done under water; but if preserved in alcohol and formaldehyd, the membrane may be removed at leisure. Brains hardened in chlorid of zinc should afterward be kept in alcohol. When the brain has been removed from a subject injected (embalmed) with chlorid of zinc, the pia mater can at once be separated and the brain placed in alcohol. If the brain from a fresh subject be immediately placed in alcohol, subsequent removal of the pia mater will be found almost impossible on account of its firm adherence. If the pia mater is not removed, the study of the convolutions is much less satisfactory. Brains which have been hardened in chlorid of zinc and afterward kept in alcohol are much easier to handle than when kept in zinc alone, as the latter, by its action on the skin, makes the fingers sticky. Brains preserved in alcohol and formaldehyd are preferable to those preserved in a solution of zinc chlorid and alcohol, because they are not shrunken so much as the latter. Brains taken from a subject embalmed with zinc chlorid should be hardened in a solution of the same; only fresh brains should be hardened and preserved in alcohol and a two per cent. solution of formaldehyd.

Processes of the dura mater.—The dura mater, through duplication of its inner or meningeal layer, sends three larger and five smaller partitions, folds, or processes into the cavity of the skull and between certain divisions of the brain;

The **falx cerebri** is a sickle-shaped process, narrowed almost to a point in front, where it is attached to the crista galli; it is broad behind, where it is attached to the middle of the upper surface of the tentorium cerebelli. It projects into the great longitudinal fissure of the brain and separates the hemispheres of the cerebrum. Its convex upper border is attached upon the inner surface of the calvaria to the edges of the groove which accommodates the superior longitudinal sinus. The concave lower border is free, arches over the corpus callosum, and contains the inferior longitudinal sinus.

The **tentorium cerebelli** is a somewhat triangular-shaped process, having its base attached upon the inner surface of the occipital bone to the edges of the groove for the lateral sinuses; the sides are attached to the line of junction of the upper and posterior surfaces of the petrous portion of the temporal bone, from the apex of which they are continued to the posterior and anterior clinoid processes. The apex corresponds to the free edge, which forms the lateral and posterior boundaries of the triangular opening known as the *superior occipital foramen or superior foramen magnum*. This foramen gives passage to the crura cerebri, the superior peduncles of the cerebellum, the oculo-motor and pathetic nerves, and the basilar artery. The tentorium cerebelli projects into the great transverse fissure of the brain and separates the posterior lobes of the cerebrum from the cerebellum. In the convex border of the base of the tentorium cerebelli the horizontal portions of the lateral sinuses are contained; in the sides, the superior petrosal sinuses; and in the middle, at its union with the falx cerebri, the straight sinus. The base of the falx cerebri is attached along the entire median line of the upper surface of the tentorium cerebelli, and the falx cerebelli to the median line of the lower surface. The tentorium serves to support the posterior lobes of the cerebrum, thus protecting the cerebellum from pressure.

The **falx cerebelli** is a small, vertical fold attached posteriorly to the internal occipital crest or inferior vertical limb of the occipital cross, and above to the under surface of the tentorium cerebelli; it is situated between the hemispheres of the cerebellum. In its posterior border is contained the occipital sinus. This border at times splits into two parts, which are attached to the sides of the back part of

up by the internal jugular veins. There are sixteen in all, and they consist of two groups: those situated at the upper and back part of the cranial cavity, and those situated at the base of the skull. The former group includes the superior longitudinal, the inferior longitudinal, the straight, the lateral, and the occipital sinuses. The last-named group includes the cavernous, the sinuses alæ parvæ, the circular, the superior petrosal, the inferior petrosal, and the transverse. They can also be divided into a median and a lateral group, the former including the single sinuses, situated in the middle line of the skull, and the latter the paired sinuses, situated on both sides of the middle line. Five are in pairs and six are single. The five pairs are the lateral, the superior petrosal, the inferior petrosal, the cavernous, and the sinuses alæ parvæ. The six single sinuses are the superior longitudinal, the inferior longitudinal, the circular, the transverse, the straight, and the occipital. Some anatomists describe the sigmoid portions of the lateral sinuses as an additional pair, thus making the number eighteen.

The **superior longitudinal sinus,** which has already been exposed, occupies the convex border of the falx cerebri. It passes from the foramen cecum at the root of the frontal crest through the mesial groove on the inner surface of the calvaria; deviating slightly to the right in the posterior part of its course, it runs to the internal occipital protuberance, to end in the torcular Herophili. The *torcular Herophili* is the point of confluence of the superior longitudinal, lateral, straight, and occipital sinuses, and is situated a little to the right of the internal occipital protuberance. The superior longitudinal sinus is triangular on section, the base being directed toward the calvaria; it is narrower in front, gradually increasing in width as it passes backward. Its lumen is crossed by a number of fibrous bands, the *chordæ Willisii*, and Pacchionian bodies are frequently found projecting into it. It receives veins from the scalp through the parietal foramina, from the diploë, the dura mater, and the hemispheres of the cerebrum. These veins, particularly those from the cerebrum,—the superior cortical,—run into the sinus from behind forward in the direction opposite to that in which the blood current passes; furthermore, they pierce the wall of the sinus very obliquely. In the fetus the sinus communicates with the veins of the nose by a small emissary vein which passes through the foramen cecum, but this seldom occurs in the adult. The superior longitudinal sinus presents a variable number of lateral outgrowths or pouches, which have been named the *lacunæ laterales.* It is into these that the Pacchionian bodies project.

Wounds of, and line for, the superior longitudinal sinus.—The relation of the sinus to the skull renders it likely to be wounded in compound fracture of the

gauze, unless the wound be small, in which case it can be closed by sutures. The course of the sinus is represented on the scalp by a straight line drawn from the root of the nose over the median line of the vertex to the external occipital protuberance.

Septic or infective processes of the scalp may enter the superior longitudinal sinus through the parietal emissary veins; septic processes of the nose may reach that sinus through the vein in which the sinus has its origin.

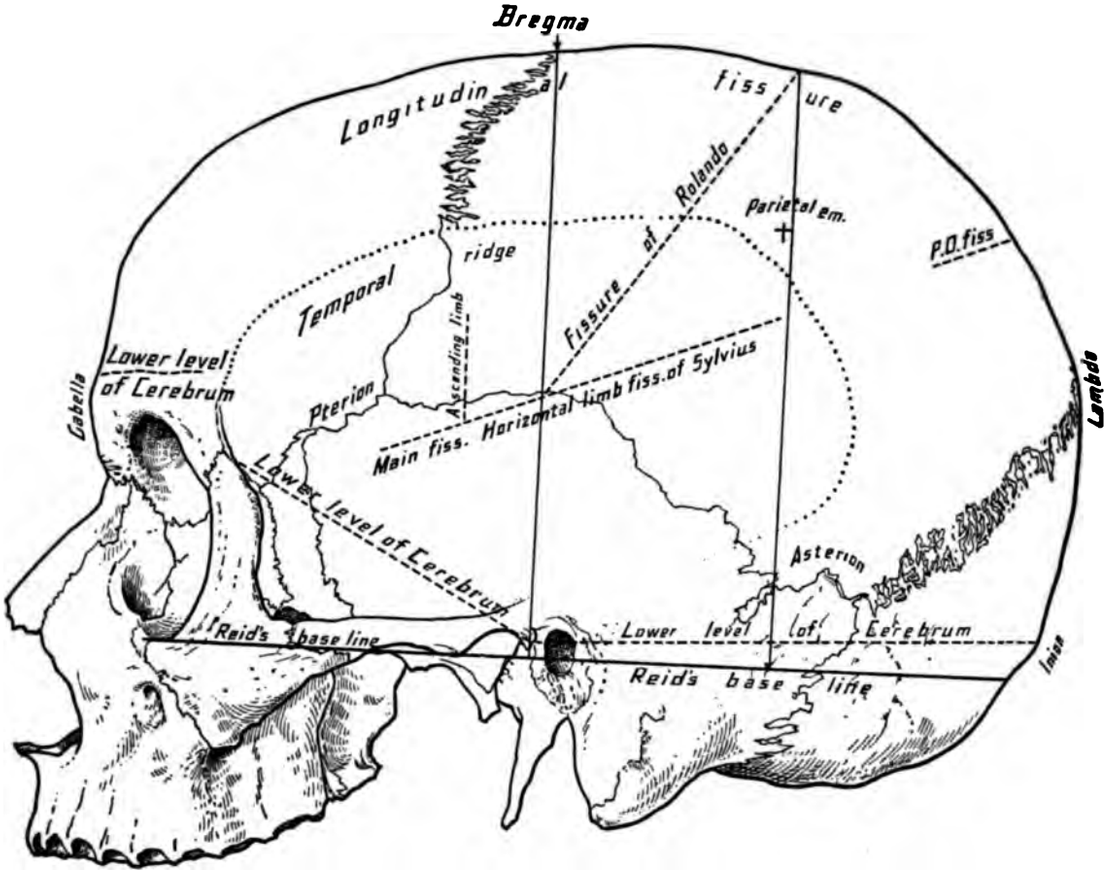
The **lateral sinuses,** the largest of the cranial sinuses, extend from the internal occipital protuberance to the jugular foramina, terminating at the beginning of the internal jugular veins. They arise on each side of the internal occipital protuberance, across which they are connected by a small branch; thence they pass outward and forward, grooving the squamous portion of the occipital, the posterior inferior angle of the parietal, the mastoid portion of the temporal, and the jugular process of the occipital bone. Each sinus consists of two portions, a horizontal and a sigmoid. The *horizontal portion* is situated in the base of the tentorium cerebelli; it is triangular on section, the base of the triangle being directed toward the occipital bone and the posterior inferior angle of the parietal bone. The *sigmoid portion* is situated below the tentorium cerebelli, and grooves the mastoid portion of the temporal and the jugular process of the occipital bone; it is semicylindric on section, and is considered by some anatomists a separate sinus—the sigmoid. The superior petrosal sinus empties posteriorly into the sigmoid portion of the lateral sinus at its origin. The lateral sinus varies somewhat in size and position, a fact to be remembered in trephining operations.

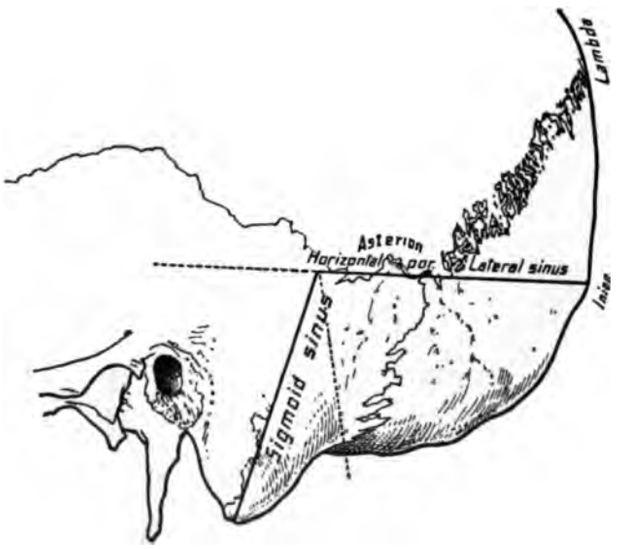
Tributaries of the lateral sinus.—The right lateral sinus is usually larger than the left; it begins at the torcular Herophili, and is the continuation of the superior longitudinal sinus. The left lateral sinus is the continuation of the straight sinus. In addition to the superior petrosal sinuses, the lateral sinuses receive emissary veins from the scalp, which pass through the mastoid and posterior condyloid foramina; veins from the diploë (the occipital and the external parietal); the lateral inferior cerebral, and some of the superior and inferior cerebellar veins.

Leeching.—A suitable site for applying leeches in meningitis is behind the ear; in this way blood is extracted directly from the lateral sinus through the mastoid emissary vein, thus depleting the intra-cranial circulation. Another, but less favorable, location for the application of leeches in meningitis is near the inner canthus of the eye, where the angular vein anastomoses with the ophthalmic vein.

Thrombosis of the lateral sinus.—The sigmoid portion of the lateral sinus, or the sigmoid sinus, is the portion of the intra-cranial venous circulation most con-

PLATE (


Bregma
Longitudinal fissure
Rolando
Parietal em.
P.O.fiss
Temporal ridge
Fissure of
Ascending limb
Lower level of Cerebrum
Glabella
Pterion
Main fiss. Horizontal limb fiss. of Sylvius
Lambda
Lower level of Cerebrum
Asterion
Reid's base line
Lower level of Cerebrum
Inion
Reid's base line


Lambda
Asterion
Horizontal fissure
Lateral sinus
Inion
Sigmoid sinus

cerned in diseases of the middle ear. Thrombosis of this portion of the sinus and of the commencement of the internal jugular vein constitutes one of the complications of suppurative middle ear disease, and is due to the proximity of the sinus to the middle ear and mastoid cells, and to the fact that veins pass directly from the mastoid portion of the temporal bone to the lateral sinus. This condition demands exposure of the sinus and removal of the clot; this is best done before general systemic infection has occurred. When sepsis is present and the mastoid antrum has been drained by trephining the mastoid process without producing the desired effect, the sigmoid portion of the lateral sinus should be exposed without delay. The presence of a clot can readily be determined by palpation; removal of the clot should immediately be followed by antiseptic packing of the sinus. The four most serious complications of suppurative otitis media are septic thrombosis of the lateral sinus, septic meningitis, abscess of the temporo-sphenoid lobe of the cerebrum, and cerebellar abscess.

Infective processes may also reach the lateral sinus from the scalp through the mastoid vein, occipital diploic and posterior temporal diploic veins, and through the superior longitudinal and the cavernous sinus.

Line for the lateral sinus.—In trephining for depressed fracture of the occipital bone, cerebellar tumor, cerebellar abscess; in opening the mastoid cells or mastoid antrum; or in exposing the sinus itself in septic thrombosis, it is highly important to bear in mind the relation of the lateral sinus to the exterior of the skull. Its course is represented as follows: Draw a line from the external occipital protuberance to a point an inch above the external auditory meatus. The sinus follows this line as far as the base of the mastoid process; thence it runs downward parallel with the middle line of the mastoid. According to Macewen, the right sigmoid groove is generally wider and deeper, projects farther outward, and reaches farther forward than the left sigmoid groove. The closer proximity of the sigmoid portion of the right lateral sinus to the middle ear perhaps explains the greater frequency of intra-cranial lesions consecutive to right-sided otitis media.

Operations on the mastoid process.—In opening the mastoid cells or mastoid antrum it is better to expose the entire surface of the mastoid process by turning up a large flap, than to expose a limited surface through a vertical incision behind the ear; this is particularly the case if the disease be advanced, when the overlying soft

the instrument at a point directly over the horizontal and behind the perpendicular line. With the trephine or gouge make an opening in a forward and inward direction. Having removed the external table, the mastoid antrum can usually be entered with a small elevator or a stiff director; this is to be preferred to the trephine or gouge, as it lessens the risk of injuring the sigmoid portion of the lateral sinus. Both the tympanum, or middle ear, and the mastoid cells can be drained through the mastoid antrum. In the majority of cases the pus is primarily in the tympanum, yet occasionally suppuration takes place *ab origine* in the mastoid cells. It must not be forgotten that in children and in many adults there are no well-developed mastoid cells; opening directly into the mastoid antrum is, therefore, the safest course to pursue in all cases.

The **inferior longitudinal sinus** is situated in the free concave margin of the falx cerebri. It is of small size, cylindric on section, and terminates in the straight sinus at the junction of the falx cerebri with the anterior margin of the tentorium cerebelli and at the posterior boundary of the superior occipital foramen. It receives veins from the falx cerebri, the median surface of the cerebral hemispheres, and the basilar surface of the frontal lobes.

The **straight sinus** is formed by the union of the inferior longitudinal sinus with the veins of Galen. It is situated at the junction of the falx cerebri with the tentorium cerebelli, and terminates at the internal occipital protuberance, whence it is continued as the left lateral sinus. It is triangular on section and increases in size as it passes backward. It receives veins from the tentorium cerebelli and the upper surface of the cerebellum (the superior cerebellar). Its direction is downward and backward.

The **occipital sinus** is formed by the union of two small veins (marginal sinuses) which pass around the lateral margins of the foramen magnum and communicate with the sigmoid portion of the lateral sinus near the jugular foramen and with the posterior spinal veins. It passes along the attached margin of the falx cerebelli to the internal occipital protuberance, where it empties into the torcular Herophili. It may empty into one of the lateral sinuses or into the straight sinus. It receives veins from the tentorium cerebelli and cerebellum, communi-

The **cavernous sinuses** are situated along the sides of the body of the sphenoid bone, and extend from beneath the anterior clinoid processes to the apices of the petrous portions of the temporal bones. The outer wall of the sinus —the most distinct—contains the third and fourth nerves and the ophthalmic division of the fifth, while the inner wall contains the internal carotid artery, the sixth nerve, and the cavernous plexus of the sympathetic. "Tillaux alludes to some cases of aneurysmal communication between the internal carotid artery and the sinus; the signs of such lesion are dilatation of the ophthalmic vein and a pulsatory swelling behind the internal angular process of the frontal bone" (Owen). The endothelial lining membrane of the sinus prevents the blood from coming into contact with the nerves and artery. Practically speaking, the inner wall of the sinus does not exist as a distinct lamella, but is formed by the structures previously enumerated as being contained therein. Section of the sinus discloses numerous bands and spaces on its interior—hence its name. The nerves which occupy the outer wall of the sinus observe the same order, both from above downward and from within outward, in which they have been mentioned. Of the structures occupying the inner wall, the sixth nerve is the most external. The sinus receives the ophthalmic vein in front, and the sinus alæ parvæ above the third nerve. It communicates with its fellow by means of the circular sinus, and divides posteriorly (at the apex of the petrous portion of the temporal bone) into the superior and inferior petrosal sinuses. It receives the middle cerebral veins and those from the basilar surface of the frontal lobe, communicating with the pterygoid plexus of veins by means of the Vesalian vein, which runs through the Vesalian foramen in the greater wing of the sphenoid bone. It also communicates with the internal jugular vein through the venous plexus surrounding the petrous portion of the internal carotid artery, and with the pterygoid and pharyngeal plexuses of veins by means of veins which run through the foramen ovale and

occupied by the Gasserian ganglion, may also be demonstrated at this time. The comparatively intimate relation existing between the sinus and the ganglion should, therefore, be borne in mind when attempting to remove the ganglion for relief of trifacial neuralgia, otherwise the sinus might be injured; an accident of this kind, it is hardly necessary to say, might be serious.

The **circular sinus,** through which the two cavernous sinuses communicate, surrounds the pituitary body. The anterior half is larger than the posterior, and in advanced life is larger than in early life. At times one-half is absent. It receives veins from the pituitary body and the neighboring bone and dura mater.

The **superior and inferior petrosal sinuses** are the terminal divisions of the cavernous sinus. The *superior petrosal sinus* runs in a small groove in the superior edge of the petrous portion of the temporal bone, in the margin of the tentorium cerebelli. It terminates in the lateral sinus at the point where the sigmoid portion of the sinus begins. At its origin it is crossed by the fourth nerve, and, in turn, crosses the fifth nerve. It receives some of the inferior cerebral and superior cerebellar veins, a vein from the middle ear which makes its exit through the petro-squamous suture, and some diploic veins.

The *inferior petrosal sinus*, which is shorter and wider than the superior, runs in the groove formed by the junction of the inferior border of the petrous portion of the temporal with the basilar process of the occipital bone, and at the jugular foramen empties into the commencement of the internal jugular vein. The terminal portion of the inferior petrosal sinus separates the glosso-pharyngeal from the pneumogastric and spinal accessory nerves. It receives some of the inferior cerebellar veins and some from the medulla oblongata and pons; veins from the internal ear which make their exit by way of the aqueductus vestibuli and aqueductus cochleæ also empty into it.

The **transverse sinus,** through which the inferior petrosal sinuses communicate with each other, passes across the basilar process of the occipital bone. It extends inferiorly as far as the anterior margin of the foramen magnum, where it communicates with the anterior spinal veins. The sixth pair of nerves pass through it. Some authors describe the transverse sinus as a plexus of veins (basilar plexus).

Blood Supply.—The blood supply of the dura mater is derived from the meningeal arteries, though the chief function of these vessels is to supply the bones of the cranium. These arteries comprise practically three sets,—an anterior, a middle, and a posterior,—and in the dried skull their course can readily be traced by following the grooves in the bones which they occupy. The meningeal arteries are accompanied by relatively small veins.

Nerve Supply.—The nerve supply of the dura mater is derived from the

Gasserian ganglion, the first, second, and third divisions of the trigeminal or fifth, the pneumogastric, the hypo-glossal, and the sympathetic nerves.

DISSECTION.—Before studying the courses of the meningeal arteries, which necessitates stripping the dura mater from the skull, examine the cranial nerves as they pass through the foramina at the base of the skull. The dura mater should then be disposed of in the foregoing manner.

INTRA-CRANIAL COURSE AND MODE OF EXIT OF THE CRANIAL NERVES.

Coverings.—In tracing the cranial nerves to their exit through the foramina at the base of the skull, observe that each pair of nerves receive investments from all three membranes of the brain. The coverings derived from the dura mater and the pia mater are continuous with the sheaths of the nerve, while that from the arachnoid terminates as the nerves enter the dura mater.

Enumeration.—The names of the twelve pairs of nerves, mentioned from before backward, are: The olfactory, the optic, the oculo-motor, the pathetic, the trifacial, the abducent, the facial, the auditory, the glosso-pharyngeal, the pneumogastric, the spinal accessory, and the hypo-glossal nerves.

The **olfactory nerves,** the first pair, consist of the olfactory tracts and bulbs, and have been removed with the brain and their branches divided. Strictly speaking, the olfactory bulb and tract are to be regarded as portions of the brain. Arising from the lower surface of the olfactory bulb are some twenty filaments,—the real olfactory nerves,—which are arranged in two rows, an inner and an outer. They supply the upper portions of the septum and the outer wall of the nose respectively, and terminate in cells in the mucous membrane. By carefully separating the dura mater from the grooves in the base of the skull on each side of the crista galli, these real olfactory nerves may be seen running through the foramina in the cribriform plate of the ethmoid bone.

The **optic nerves,** the second pair, pass through the optic foramina accompanied by the ophthalmic artery.

The **oculo-motor nerves,** the third pair, pierce the dura mater near the ante-

external rectus, and also supply the circular muscular fibers of the iris and the ciliary muscle.

The **pathetic nerves** (trochlearis), the fourth and smallest pair of cranial nerves, pierce the dura mater near the free edge of the tentorium cerebelli, a little behind the posterior clinoid processes and above the oval openings for the fifth nerves. Each enters the outer wall of its respective cavernous sinus, where it lies below the third nerve and above the ophthalmic nerve, and passes into the orbit through the sphenoid fissure, in which it lies above the third nerve and the ophthalmic division of the fifth. It supplies the superior oblique or trochlearis muscle.

The **trifacial nerves,** the fifth pair, have two roots,—a larger sensory and a smaller motor,—and pass through an oval opening in the dura mater beneath the free border of the tentorium cerebelli. Above the fifth nerve is the fourth nerve, and below it are the apex of the petrous portion of the temporal bone and the internal auditory meatus. Upon the larger or sensory root is the Gasserian ganglion, which can not be seen until the dura mater is raised from the base of the skull. Its description will therefore be deferred until this has been done. The ophthalmic branch of the trifacial nerve is exposed, and is seen running through the outer wall of the cavernous sinus, where it lies beneath the fourth nerve. It divides into three branches,—the lacrymal, frontal, and nasal,—after which it enters the orbit by way of the sphenoid fissure. In the wall of the sinus the ophthalmic branch is joined by filaments from the carotid plexus of the sympathetic nerve, communicating with the third, fourth, and sixth nerves, and giving off a recurrent branch which passes backward between the layers of the tentorium cerebelli.

The **abducent nerves,** the sixth pair, pierce the dura mater behind the body of the sphenoid bone immediately below the posterior clinoid processes, and pass through the transverse sinus. Each then courses along the inner wall of the cavernous sinus to the outer side of the internal carotid artery, and enters the orbit by way of the sphenoid fissure, lying between the ophthalmic vein and the inferior branch of the oculo-motor nerve. It supplies the external rectus muscle, between the two heads of which it passes. Within the wall of the cavernous sinus it is

The **auditory nerves,** the eighth pair, leave the cranial cavity through the internal auditory meatuses in company with the auditory arteries, the facial nerves, and the pars intermedia. Reaching the bottom of the meatus each nerve divides into two branches, the cochlear and the vestibular, for the supply of the cochlea, the vestibule, and the semicircular canals.

The **glosso-pharyngeal nerves,** the ninth pair; the **pneumogastric** (vagus), the tenth pair; and the **spinal accessory,** the eleventh pair, leave the cranial cavity by way of the jugular or posterior lacerated foramen, passing through its middle compartment. The glosso-pharyngeal nerves have a separate sheath of dura mater and arachnoid, and lie in front of the pneumogastric and spinal accessory nerves. The last-mentioned two have a sheath of dura mater common to both, but they have separate sheaths of arachnoid. The spinal accessory nerve is made up of two parts: a smaller or accessory portion (accessory to the pneumogastric nerve), which runs with the pneumogastric, and a spinal, which arises from the spinal cord, and is by far the larger portion. The latter enters the cranial cavity through the foramen magnum and joins the accessory portion shortly after the latter emerges from the medulla.

The **hypo-glossal nerves,** the twelfth pair, leave the cranial cavity through the anterior condyloid foramina.

The internal carotid artery.—When the cavernous sinus has been laid open and the nerves within its wall exposed, carefully examine the internal carotid artery running in the inner wall of the sinus before disturbing the dura mater further. After its exit from the carotid canal, the curves which the artery makes in reaching the brain can now be seen to the best advantage. Having emerged from the carotid canal the artery turns upward, passing toward the posterior clinoid process. It next runs forward through the inner wall of the sinus to reach the inner side of the anterior clinoid process, where it again turns upward and pierces the dura mater on the inner aspect of the anterior clinoid process; just before piercing the dura mater it gives off the ophthalmic branch. The cranial or terminal portion thus makes two bends, which give it the shape of the letter **S.** Running along with the artery and external to it is the abducent (sixth) nerve. The lining membrane of the sinus alone separates both the artery and the nerve from the interior of the sinus. Within the walls of the sinus the artery gives off branches known as the arteriæ receptaculi, which supply the walls of the sinus, the pituitary body, the Gasserian ganglion, and the dura mater (through the anterior meningeal). It is surrounded by filaments of the sympathetic nerve

motor, pathetic, and ophthalmic nerves, and furnishes the sympathetic root to the ophthalmic or lenticular ganglion.

DISSECTION.—The dura mater should now be dissected from the sides and base of the skull; it will be found closely adherent to the latter, requiring care in its removal in order to avoid injuring the following structures: The Gasserian ganglion, the superior and inferior maxillary nerves, which are branches from the ganglion, the large superficial petrosal, the external superficial petrosal when present, and the motor root of the trifacial nerve. The last and the large superficial petrosal nerve run beneath the ganglion.

The **Gasserian ganglion** occupies a depression on the superior surface of the petrous portion of the temporal bone near the apex, and rests to a slight extent on the cartilage filling the middle lacerated foramen. It holds an intimate relation, therefore, to both the internal carotid artery and the cavernous sinus. It is crescentic in outline, its concavity being directed backward and its convexity forward and outward, and it measures about one-half of an inch in width. Its upper and lower surfaces are slightly convex. It occupies an interval between the endosteal and meningeal layers of the dura mater (*Meckel's space*), and for this reason the endosteal layer of the dura mater must be divided in attempting its removal through the side or base of the skull. From the convexity of the ganglion arise the ophthalmic, superior maxillary, and inferior maxillary nerves, the first two being sensory nerves throughout. The inferior maxillary nerve is sensory until it reaches the outside of the skull; here it is joined by the motor root of the trifacial nerve, which leaves the cranial cavity with it by way of the foramen ovale; the inferior maxillary thus becomes a mixed nerve.

The **superior maxillary nerve,** intermediate in size between the ophthalmic and the inferior maxillary, leaves the cranium by way of the foramen rotundum.

The **inferior maxillary nerve,** the largest branch of the fifth, leaves the cranial cavity by way of the foramen ovale which also transmits the small superficial petrosal nerve and the small meningeal artery.

Intra-cranial neurectomy of the superior and inferior maxillary nerves.—This is one of the operations for relief of trifacial neuralgia, and is performed in the following manner: An Ω-shaped flap is made over the temporal region, beginning near the tragus of the auricle and carried upward to about the level of the temporal ridge, ending near the external angular process of the frontal bone. All the structures down to the bone are divided. They include the skin and superficial fascia, the attrahens aurem muscle, the temporal branches of the facial and auriculo-

the line of the original incision, preferably with an instrument specially constructed for this purpose. Care must be taken to avoid injuring the membranes of the brain. An elevator is introduced beneath the bone after it has been cut through along the whole line of the incision, and the entire flap is forced outward and downward. The bone will fracture between the ends of the oval incision a little above the line of the zygomatic arch. The bone and soft structures should be reflected as one flap in thus exposing the dura mater of the brain. When the middle meningeal artery lies in a canal in the temporal and parietal bones, it may be torn in forcing the flap downward. This necessitates tying the vessel or plugging the canal for the vessel with gauze, as the bleeding would be severe. The dura mater is separated from the floor of the middle cranial fossa, and when the brain is lifted upward, the superior and inferior maxillary divisions of the fifth or trifacial nerve will be exposed. As much as possible of both nerves is then excised, and the distal ends pushed through their respective foramina of exit. The operation is completed by repositing the flap of bone, suturing the soft parts, and dressing the wound.

Removal of the Gasserian ganglion.—In removing the Gasserian ganglion one of two routes can be selected, either through the side of the skull or through its base; the latter method was first practised by Mr. Rose. In the former method, by far the most preferable, an osteo-plastic resection of the side of the skull is made, similar to that in the previous operation. The flap of bone includes part of the frontal, greater wing of the sphenoid, parietal, and the squamous portion of the temporal bone. After the superior and inferior maxillary nerves are exposed, they should be traced backward to the Gasserian ganglion; this is lodged in a depression near the apex of the petrous portion of the temporal bone, in a space (Meckel's) situated between the two layers of the dura mater. The outer layer of the dura mater should be incised, and the ganglion removed. The inferior and superior maxillary divisions of the trifacial nerve are then resected up to their point of exit from the skull, and the distal ends pushed through their respective foramina. The inferior maxillary nerve leaves the skull through the foramen ovale; the superior maxillary nerve through the foramen rotundum. The osteo-plastic flap is then replaced and the wound closed. The first steps of this and the succeeding operation will be greatly facilitated

the temporal muscle; this exposes the internal maxillary artery and pterygoid muscles. The internal maxillary artery should be tied at two points and divided. The external pterygoid muscle should then be carefully detached from its origin, thus exposing the inferior maxillary nerve as it emerges from the foramen ovale, which is the point at the base of the skull to be attacked with the trephine. If the inferior maxillary nerve has not been removed by a previous operation, it acts as an important guide in locating the foramen. The eminentia articularis and the root of the pterygoid process are additional guides, the foramen being usually just in front of a transverse line drawn through the eminence, and immediately behind the root of the external pterygoid plate. When the foramen has been clearly exposed, apply a small trephine, one-half of an inch in diameter, to the base of the skull and remove a button of bone which includes the margin of the foramen. The proximity of the foramen to the carotid canal renders this step a very important one. The disc of bone having been removed, the exposed dura mater, which bulges more or less into the trephine hole, should be opened and the inferior maxillary nerve, if not already exposed, sought. When found, it is traced to the Gasserian ganglion, which is then removed piecemeal. The operation is completed by replacing the tissues in as nearly the normal position as possible; the zygoma and the bone on each side of it are drilled and sutured, drainage is introduced, and the wound closed. The button of bone is not replaced. Extreme care should be exercised throughout this operation, which is one of great magnitude. The nutrition of the eyeball may be so seriously affected as to result in its destruction.

Dissection.—To continue the dissection, divide the larger or sensory root of the trifacial nerve, lift the Gasserian ganglion, and displace it forward and downward so as to better expose the smaller motor root and the large superficial petrosal nerve, both of which lie beneath the ganglion. The motor root of the trifacial nerve can be traced to the foramen ovale, where, with the inferior maxillary nerve, it makes its exit from the skull.

The **large superficial petrosal nerve** arises from the geniculate ganglion of the facial nerve, and will be seen emerging from the hiatus Fallopii. Thence it

The **external superficial petrosal nerve** leaves the facial nerve and canal by way of a small foramen placed external to that for the small superficial petrosal nerve, on its way to join the plexus of the sympathetic upon the middle meningeal artery. This nerve is seldom found in the dissection of the interior of the base of the cranium, for in lifting up the endosteal layer of the dura mater the petrosal nerves are very apt to be severed unless the utmost care is observed.

The **Meningeal Arteries**—the anterior, the middle, the small, and the posterior meningeal—run between the skull and the dura mater, and are apt to be destroyed, or at least cut, when removing the dura mater; notwithstanding this they can be traced by the grooves in the bones which they occupy. The greater part of the anterior branch of the middle and the terminal part of the posterior meningeal arteries have been observed when removing the calvaria.

The **middle meningeal artery.**—The largest and most important of the meningeal arteries is the middle. As seen when dissecting the pterygo-maxillary region, both this and the small meningeal are branches of the internal maxillary artery. The middle meningeal artery runs between the two roots of the auriculo-temporal nerve and enters the cranial cavity by way of the foramen spinosum; it occupies a groove in the greater wing of the sphenoid bone, and almost immediately divides into two branches, the anterior and the posterior. Small branches of the middle meningeal artery pierce the cranial bones and anastomose with the vessels of the scalp.

The *anterior branch* runs through a groove across the great wing of the sphenoid, and continues into another groove in the anterior inferior angle of the parietal bone. The commencement of this latter groove for a distance of one-fourth to one-half of an inch is often bridged over by a thin plate of bone, and is thus converted into a canal. The vessel continues along the groove near the anterior border of the parietal bone, runs almost parallel with the coronal suture to within a short distance of the superior longitudinal sinus, and gives off branches which run upward to the vertex and backward toward the occipital bone. The sinus alæ parvæ or spheno-parietal venous sinus at times accompanies the artery for a part of its course, and may consequently be injured in fracture or during the manipulations of the surgeon.

The *posterior branch*, the smaller of the two, crosses the squamous portion of the temporal bone along the line of junction of the squamous with the petrous portion, and then upon the posterior inferior angle of the parietal bone, where it divides into its branches.

Extra-dural hemorrhage.—From the relation which the anterior branch of the middle meningeal artery holds to the anterior inferior angle of the parietal bone, it follows that fracture of this part of the skull is apt to result

in hemorrhage, which would be located between the bone and the dura mater. The vessel may be injured either by sharp bony spicula or by the sudden alteration in shape to which the skull is subjected in cases of severe head injury. It has already been noted that the dura mater is loosely attached to the vault of the cranium; this accounts for the size of the large extra-dural blood-clots occasionally seen. From the relation of this branch to the motor area of the brain it can readily be understood why the symptoms consequent upon the pressure of an extra-dural clot are largely, if not altogether, motor. These cases constitute an especially favorable class for trephining, which should be done as soon as the diagnosis is made, or as early as possible. If upon the removal of the clot the bleeding has not ceased, the vessel should be tied. This may necessitate enlarging the original trephine opening in order to expose the bleeding points. The author has found it necessary to tie both the anterior and the posterior branch. It occasionally happens that the injury to the middle meningeal artery occurs on the opposite side to that upon which the external lesion exists.

Point for trephining.—The point of election for applying the trephine in a suspected case of extra-dural hemorrhage, meningeal in origin, is at a point one and one-half inches behind and one inch above the external angular process of the frontal bone. When a simple or a compound depressed fracture is associated with the hemorrhage, the trephine should be applied near the fracture. To reach the posterior branch the trephine should be applied immediately below the parietal eminence, and on the same horizontal level as in the preceding operation. The opening can subsequently be enlarged in a downward or backward direction and the vessel thus brought into view.

Branches of the middle meningeal artery.—The middle meningeal artery gives off branches within the cranial cavity to the Gasserian ganglion: a petrosal branch, which enters the hiatus Fallopii to supply the facial nerve and anasto-

anastomoses with the middle meningeal artery, and it also receives the name of anterior meningeal. The dura mater of the middle cranial fossa is supplied chiefly by the *small meningeal artery*, a branch of the internal maxillary, which enters the cranial cavity by way of the foramen ovale, and one or two branches from the ascending pharyngeal artery, which enter the cranial cavity through the middle lacerated foramen.

The **posterior meningeal arteries** are the cranial branches of the ascending pharyngeal, the occipital, and the vertebral arteries; those arising from the ascending pharyngeal and the occipital artery enter the cranial cavity by way of the posterior lacerated or jugular foramen, and those from the vertebral artery by way of the occipital foramen (foramen magnum); they supply the dura mater of the occipital or posterior cranial fossa.

The ascending pharyngeal artery also sends a meningeal branch through the middle lacerated foramen, and an occasional one through the anterior condyloid foramen.

The **meningeal veins,** with the exception of those accompanying the middle meningeal artery, empty into the sinuses.

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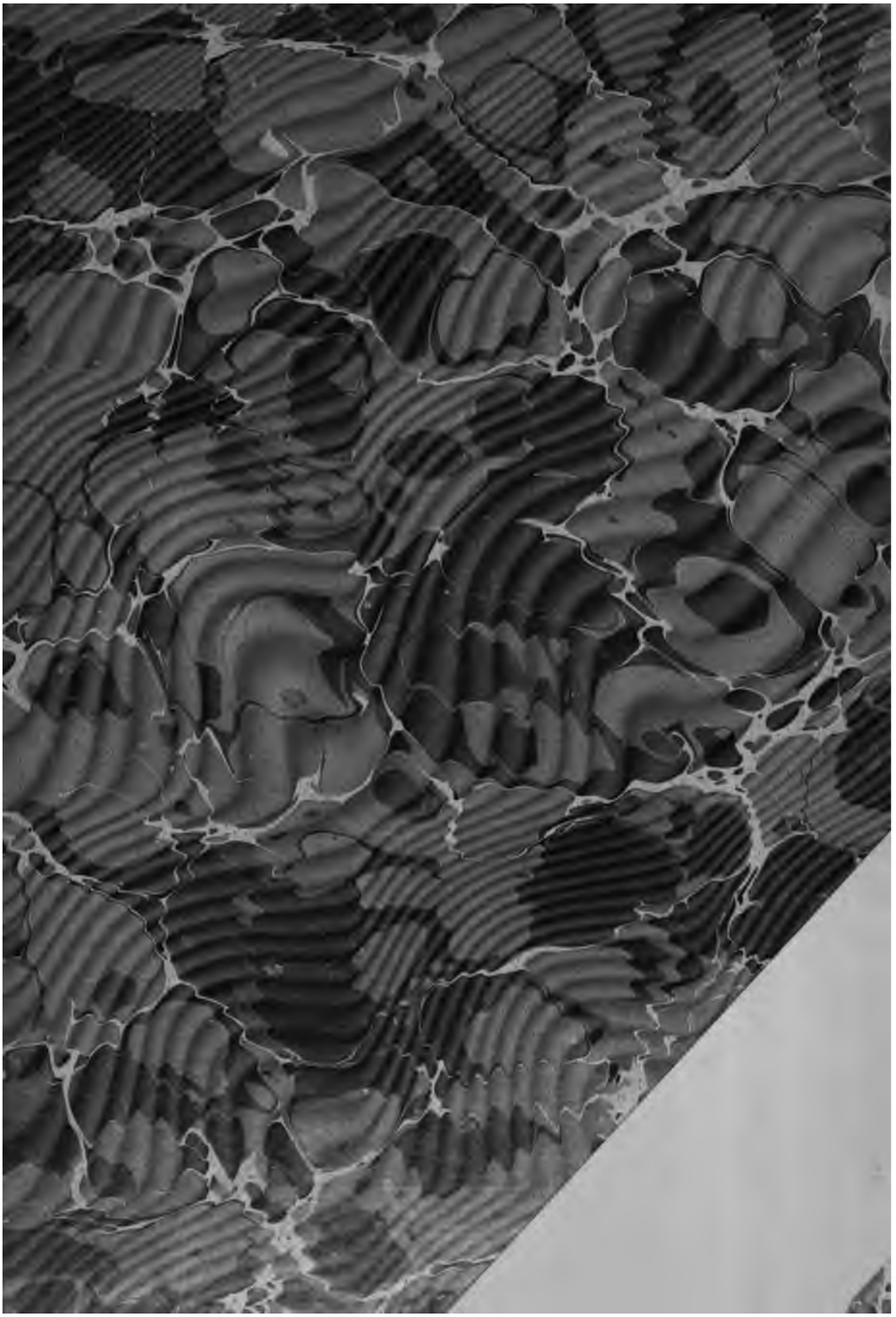
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